Thomas Creek Project

Hydrology Report

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for:
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Introduction

The purpose and need and proposed action are described in the Thomas Creek Project Description (USDA Forest Service 2014a). Four action alternatives were developed to address the purpose and need (USDA Forest Service 2014b). The Thomas Creek Project area is 15,782 acres and encompasses about 3,000 acres in the Umatilla River Subbasin and 13,000 acres within the Grande Ronde River Subbasin. The Umatilla River is a tributary to the Columbia River and the Grande Ronde River is a tributary to the Snake River.

The project proposes commercial timber harvest, commercial thinning, non-commercial thinning, mechanical fuel treatments, prescribed burning, road use, road reconstruction and road maintenance. The action alternatives propose to utilize 29-35 miles of open and seasonally open roads, 10-18.5 miles of temporarily re-opened Level 1 (closed) roads and 0.75-1 mile of non-system temporary roads to access treatment units, depending on alternative. The project also proposes large woody material placement into Phillips Creek to improve fish habitat.

The project includes non-commercial thinning along riparian areas associated with anadromous fish-bearing streams (Class I), non-commercial thinning and commercial harvest along riparian areas associated with perennial non-fish bearing streams (Class III) and non-commercial thinning and commercial harvest along riparian areas associated with intermittent streams (Class IV). The following table summarizes the alternatives related to vegetation treatments:

Table 1: Thomas Creek Project vegetation treatment alternatives (acres)

Logging System	Alt B	Alt C	Alt D	Alt E
Tractor	765	814	494	928
Forwarder	374	430	398	572
Skyline	132	84	57	292
Commercial	1270	1328	949	1793
Hand (non commercial)	1276	1270	1468	1259
Total Treatment Acres	2546	2598	2417	3068
RHCA Treatments	690	655	606	690

This report will disclose the expected direct, indirect and cumulative effects of the alternatives on water quality, water yield, peak flows, stream channel condition and riparian function. The proposed project includes active restoration elements and project monitoring. The project area contains 14 miles of water quality limited (303[d]) streams. A Watershed Analysis (a.k.a. ecosystem analysis at the watershed scale) has been completed for the Thomas Creek, Phillips Creek and Dry Creek subwatersheds. A watershed analysis is a prerequisite for active restoration within PACFISH RHCAs (USFS-BLM 1995).

Water quality parameters potentially affected with the action alternatives are sedimentation and temperature. ODEQ has prepared Total Maximum Daily Loads (TMDLs) and Water Quality Restoration Plans for the Umatilla and Upper Grande Ronde Subbasins. Proposed activities would help meet the long term goal of these TMDLs and WQRPs by restoring structure and composition of upland forests and riparian corridors and improving channel dynamics by adding large wood. Implicit to the success of this project is the selection, design, implementation, enforcement, monitoring and adjustment of best management practices for the protection of soil and water resources.

Attachments include the following:

1. Rosgen Stream Classification System
2. Rosgen Pool-to-Pool Central Tendency
3. Springs and Water Sources
4. Phillips Creek Fire Perimeter
5. Design Features and Best Management Practices
6. Class I and III RHCA Treatment Units
7. WEPP Road Model Summary

Summary of Purpose and Need

Restoration of the Thomas Creek Area is needed to:

- Manage toward HRV at the landscape scale by
  - Decreasing off-site ponderosa pine and increasing western larch
  - Decreasing stem exclusion and increasing stand initiation forest structure
  - Decreasing high density forests
- Ameliorate detrimental soil conditions.
- Mange Riparian Habitat Management Areas toward PACFISH (Forest Plan) Riparian Management Objectives.
- Provide forest products to assist in meeting local and regional social, cultural, and economic needs.

The objective of RHCA treatments would be to restore riparian and aquatic resources which have been altered by historic timber harvest and/or off-site ponderosa pine planting by:

- Restoring native vegetation diversity for the long term through
  - Removal of off-site ponderosa pine within the RHCA
  - Regeneration of native conifer species
  - Planting of local native conifers and hardwoods where appropriate
- Improving pool frequency, large woody debris, width/depth ratios and water temperature through
  - Placement of large woody debris in streams
  - Planting or otherwise encouraging growth of stream shading vegetation in those areas where it has been reduced by past activities

Issues

Scoping identified 5 key issues and 3 non-key issues. This analysis addresses the following issues:

- Key Issue 2: Access Management (Use of temporary roads and opening closed roads)
  - Measure 2a. Miles of temporary roads utilized by alternative
  - Measure 2b. Miles of existing closed roads utilized by alternative
- Key Issue 5: RHCA restoration
  - Measure 5a. Acres of RHCA with restoration treatment
  - Measure 5b. Acres with RHCA restoration commercial harvest

Resource Indicators and Measures

Indicators and Measures

Indicators used to analyze effects of proposed actions are listed in Tables 2 and 3.

Table 2: Resource indicators and measures for assessing effects to water quality and water quantity

Resource Element	Sub-Element	Measure	Addresses P/N or issue?	Source
Water Quality	Temperature	water temperature; RHCA canopy density	yes	LRMP, ODEQ 303(d) and TMDLs
	Shade	RHCA canopy density		
	Sedimentation	RHCA road density; roads in RHCAs; number of stream crossings; turbidity		
	Biological Criteria	macroinvertebrate communities		
Water Yield	Changes in Peak/Base Flows	road density (mi/mi^2); number of stream crossings; ETA	yes	LRMP

Table 3: Resource indicators and measures for assessing effects to riparian-wetland areas

Resource Element	Sub-Element	Measure	Addresses P/N or issue?	Source
RHCA Condition	Channel morphology	width/depth ratio; substrate composition; pool frequency; large wood	yes	PACFISH; LRMP; Rosgen 1996
	Riparian Soil Condition	roads in RHCAs; RHCA road densities; number of stream crossings; detrimental soil condition in RHCAs	yes	LRMP
	Floodplain Function	roads in RHCAs; number of stream crossings; large wood	yes	LRMP; E.O. 11988
Wetlands & Groundwater Dependent Ecosystems	Wetland function	Roads in RHCAs; detrimental soil condition in RHCAs	no	LRMP; E.O. 11990

Methodology

The methodologies used for hydrologic analysis conform to the best available science and accepted professional practices for managing forest and other associated natural resources, and are in accordance with the best professional judgment of practicing professional watershed specialists. The analysis incorporated existing water quality and habitat data collected from within and near the project area, geospatial data from the USFS GIS database, field reconnaissance, review of USGS and USFS streamflow data, review of USFS and ODFW stream thermograph data, review of ODEQ 303(d) database and TMDLs, review of published and unpublished studies and professional literature, air photo review and professional judgement. Benchmarks for comparing indicators include Forest Plan standards and guidelines as amended by PACFISH, State of Oregon water quality standards and published literature. Sediment data collected by USFS from the Umatilla Barometer Watershed study were utilized to establish background sedimentation rates. Precipitation records for the High Ridge Evaluation Site and High Ridge SNOTEL (NRCS) site were reviewed and summarized.

Project area, unit sizes, road and stream lengths, past activities, stream class, fish distribution, geology, roads, vegetation, soils are derived from Geographic Information System (GIS) databases which are maintained by the Forest Service. Feature locations (streams, roads, springs, harvest units, etc), distances (feet, miles), area (acres, mi^2) and other analysis tools (hillslope gradient, soils data, vegetation data, etc) are all managed using geodatabases.

Background historic, climatic, geologic, and hydrologic information may be found in Forest Service and other agency documents and surveys, and scientific literature. References are cited accordingly. Specialist reports for Soils, Vegetation, Fuels and Transportation Management are cited where appropriate. Information for activities and conditions on lands managed by other parties and organizations are generally known, but specific acreages, road miles, and years of treatment are not integrated into the GIS system. Analysis of cumulative effects will include Forest Service activities with the potential to influence watershed conditions. The Upper Grande Ronde Subbasin and Umatilla River Basin TMDLs and Water Quality Management Plans describe other sources of point and nonpoint pollution which occur on non-National Forest System lands.

Analysis indicators used to summarize past, present, and future conditions include road density and road-stream crossings. These parameters represent the potential for increased drainage efficiency (rate of runoff) from roads compared to the unroaded condition. Rain water and snow melt run off more rapidly along low infiltration rate road surfaces and into streams at crossings, compared to the rate of infiltration into forest soil. Riparian road density is a more direct indication of potential road effects to streams. Increases in road density and road crossings of streams can increase watershed efficiency, which in turn can influence stream bank stability and sedimentation. Roads that intersect or parallel streams may extend channel networks, contribute polluted runoff direct to streams, and alter shade and temperature conditions.

The WEPP Model (Flanagan and Livingston 1995) is a physically-based soil erosion model that can provide estimates of soil erosion and sediment yield by considering the specific soil, climate, ground cover, topographic condition, and management activity. The model has several web-based USFS interfaces: http://forest.moscowfsl.wsu.edu/fswepp/. The Disturbed WEPP module was used by the Forest soil scientist to model hillslope erosion due to vegetation treatments and burning and to develop appropriate no-skid buffers between streams and treatment areas (see Soils Report). The WEPP Road (Elliot et al 1999) module was used to compare road-derived sediment among alternatives. Model descriptions and assumptions are available on the website.

A method commonly used to evaluate harvest effects on water yield and peak flow is the Equivalent Clearcut Acre (ECA) analysis (King 1989). A procedure was developed for the Umatilla National Forest as part of Endangered Species Act consultation (Ager and Clifton 2005). ECAs were calculated following the Umatilla National Forest protocol to determine existing levels of harvest and estimate potential water yield and peak flow effects in the analysis area. Percent ECA measures the extent of harvested openings and is used as an indirect measure of the hydrological effects (increases in water yield and peak flow) of harvesting. The procedure to determine percent ECA includes harvest method and vegetative recovery rates developed for the Blue Mountains. Roads are included in the calculation of ECA as part of this analysis.

The ECA model accounts for changes in the forest canopy caused by past timber harvest, wildfires, insect infestations, and road construction. Effects of actions and events are pro-rated over time to model their recovery on the ground. The ECA model assumes that harvests which remove certain percentages of basal area recover hydrologically over certain periods of time, depending on the plant associations. The ECA model assumes that project implementation would span 1 year, and be completed by the end of 2016. This assumption affects the timing of the response indicator of the ECA. In actual practice, the activities would be likely take approximately 5 to 10 years to fully implement.

Model results should be considered relative values only (not absolute predictions) for purposes of comparing background and activity effects. Actual conditions and activities are more complex than those used to make model estimates. For example, the WEPP model assumes that project activities would take place in one year, when actually they would take approximately 5 to 10 years. However, the assumptions and simplifications provide a reasonable analysis and estimation of project effects for purposes of comparing relative differences with and without activities and between alternatives.

Scale of Analysis

The Thomas Creek project area contains 15,782 acres. The project is located in portions of four subwatersheds (Table 4). The hydrologic effects of proposed actions will be analyzed for National Forest System (NFS) lands by Hydrologic Unit Code 6 (HUC6), also known as a subwatershed (SWS). Cumulative effect indicators including Equivalent Treatment Acres (ETA) are reported by HUC 6. PACFISH Riparian Management Objectives (RMOs) are watershed scale (HUC5) indicators of good habitat for anadromous fish. All of the RMO features may not occur in a specific segment of stream, but generally should occur at the watershed scale. Oregon Department of Environmental Quality (ODEQ) identifies water quality limited stream reaches which are reported in miles.

Table 4: Subwatersheds encompassing the Thomas Creek Analysis Area

Subwatershed (HUC6)	SWS Name	SWS acres	NFS in SWS	Project Area	% Project Area in SWS
170601040801	Dry Creek	14,740	7,184	5,332	36%
170601041101	Phillips Creek	24,762	17,389	7,480	30%
170701030101	Thomas Creek	12,325	12,325	2,962	24%

The project area includes 8 acres in North Fork Meacham HUC6 and this small area is not included in the subwatershed scale analysis

Cumulative Effects Geographic Boundary

Cumulative effects for hydrologic indicators will be analyzed using NFS lands in HUC 6 subwatersheds. This geographic extend encompasses the area that reasonably could be affected by the Thomas Creek Project. Cumulative effects to water quality are based on the stream reaches identified by Oregon Department of Environmental Quality. Cumulative effects for fish habitat parameters are defined by PACFISH at the watershed (HUC 5) scale.

Cumulative Effects Temporal Boundary

Cumulative effects for water quality will be analyzed for short term 1 day to 1 week and for long term, up to one runoff season. These time scales were chosen to display short term concentrated effects, and longer term seasonal effects that are sometimes seen during spring runoff.

Cumulative effects for water yield are calculated using records of timber harvest activity dating to the 1950s. The Equivalent Treatment Acre (ETA) model has a 33 year time-frame for the slowest sites to recover hydrologically (collection, storage, and release of precipitation). Although vegetation management proposed in the project may occur over a number of years, the calculation assumes all treatments occur in 1 year, and therefore shows the maximum effect that could be expected.

Assumptions

The current condition of aquatic and riparian resources is assumed to be a result of natural phenomenon (such as floods, drought, historic natural fire regimes) and anthropogenic actions (timber harvest, road construction, livestock grazing, fire suppression). It is assumed that resources which exhibit a low departure from their range of natural variability will respond quickly to active management and that resources which exhibit a high departure will require more intensive management and require longer periods of time to return to their range of variability. The background sediment rate of 18 tons/mi^2 measured at the High Ridge Evaluation Area of the Umatilla Barometer Watershed is assumed to be the natural background rate for the Thomas Creek Project.

Information Sources

Numerous documents, reports and studies were reviewed pursuant to this analysis and these are referenced as appropriate. The projects and reports listed in Table 5 are more site-specific and provide information, data, or analyses directly relevant to the Thomas Creek Project area. These documents help characterized the physical, chemical and biological condition of the project area and are incorporated by reference. Specialist reports for vegetation, fire-fuels, soils, transportation and range were reviewed and cited where appropriate.

Table 5: Project-related reports

Project or Report	Year	Location	Source
North End Sheep Allotment	2011	Phillips Creek, Dry Creek, Thomas Creek, Spring Creek	WWRD
Pedro Colt Timber Sale and Fire Reintroduction Project	2004	Phillips Creek, Dry Creek	WWRD
Plentybob Ecosystem Restoration Project	2005	Thomas Creek, Spring Creek	WWRD
Phillips Creek Watershed Analysis	2002	Phillips Creek	GRMW
Phillips-Gordon Ecosystem Analysis	2001	Phillips Creek, Dry Creek	UNF
Umatilla-Meacham Ecosystem Analysis	1999	Thomas Creek, Spring Creek	UNF
Umatilla River Basin TMDL and Water Quality Management Plan	2001	Thomas Creek, Spring Creek	ODEQ
Upper Grande Ronde River TMDL and Water Quality Management Plan	2000	Phillips Creek, Dry Creek	ODEQ
Umatilla Barometer Watershed, High Ridge Evaluation Area	1995	Long term watershed study located adjacent and to the north of the Thomas Creek Project area	Helvey and Fowler 1995

WWRD=Walla Walla Ranger District, GRMW=Grande Ronde Model Watershed (Herbst 2002); UNF=Umatilla National Forest; ODEQ=Oregon Department of Environmental Quality

Incomplete and Unavailable Information

The streamflow regime has not been field verified for all streams within the analysis area. Some streams identified in GIS as Class IV (intermittent) may actually be Class III (perennial) streams and vice-versa.

There are no published streamflow records for Dry Creek subwatershed. There are no recent streamflow records for Phillips Creek. Water quality data other than stream temperature have not been collected from Dry Creek on NFS lands. Limited suspended sediment data were collected from Phillips Creek on NFS lands. Direct measurements of riparian shade or canopy cover have not been collected on NFS lands. Canopy cover estimates are from stand exam data and air photo interpretation. Data outside of the forest service boundary may be incomplete or missing (e.g. streams, roads, riparian areas) and GIS calculations of length and area for these parameters on a subwatershed scale may be underreported.

Affected Environment

Existing Condition

Climate

Climate in the project area is mixed maritime/continental with strong seasonal temperature variation and a winter precipitation maximum. Summers are typically warm and dry with occasional localized convective storms. Early winter rain changing to snow as the season progresses recharge soil moisture. Snow can accumulate throughout the project area but is transient below 3,000 feet, and variable year to year between 3,000 and about 4,000 feet, the so-called "rain on snow" zone. Above 4,000 feet, snow generally persists through the winter months. Annual precipitation increases with elevation from less than 15 inches near Summerville (2,705 ft) to about 50 inches at the High Ridge Evaluation Area (4,920 ft, Figure 1).

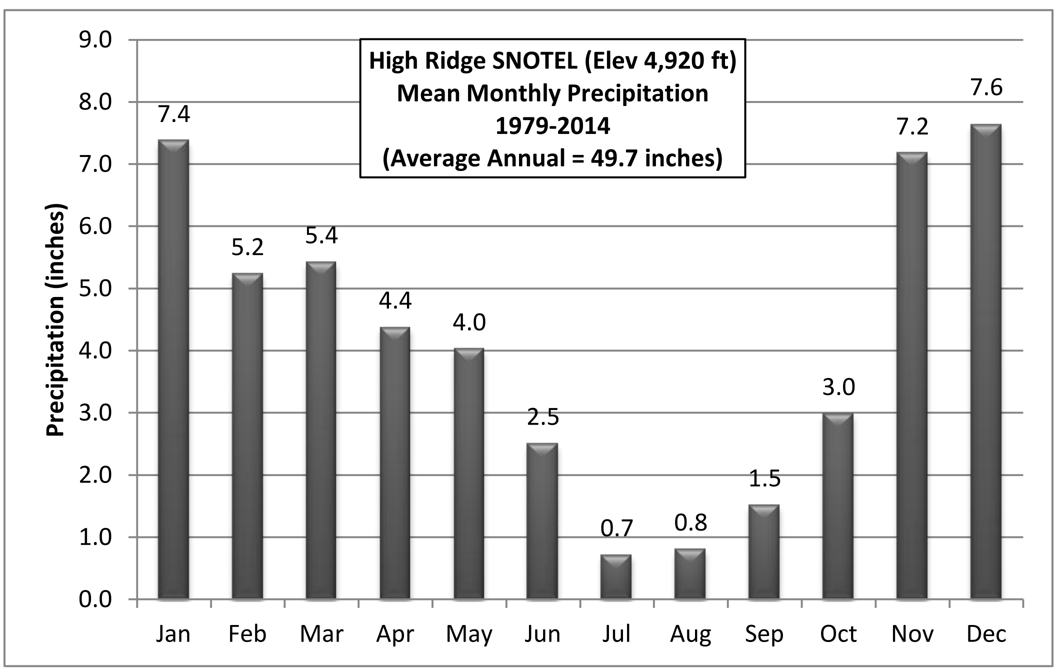

Figure 1. High Ridge SNOTEL precipitation summary (NRCS 2014)

About 75% of the annual precipitation occurs between November and May. Snowpack depth peaks in late March at higher elevations (Figure 2). Snowmelt at lower elevations begins in February and progresses upslope. Flow is generally dominated by snowmelt with peaks in the spring and low flow in

August and September. The largest peak flows in eastern Oregon are generally not the result of snowmelt; rather they are the result of warm rain falling on snow and frozen ground (Cooper 2006). The Regional rain-on-snow events in 1964 and 1996 caused large scale flooding in the Umatilla and Grande Ronde River systems. Within the project area, high stream flows scoured channels, caused lateral channel movement, and moved large volumes of bedload, sediment and other debris.

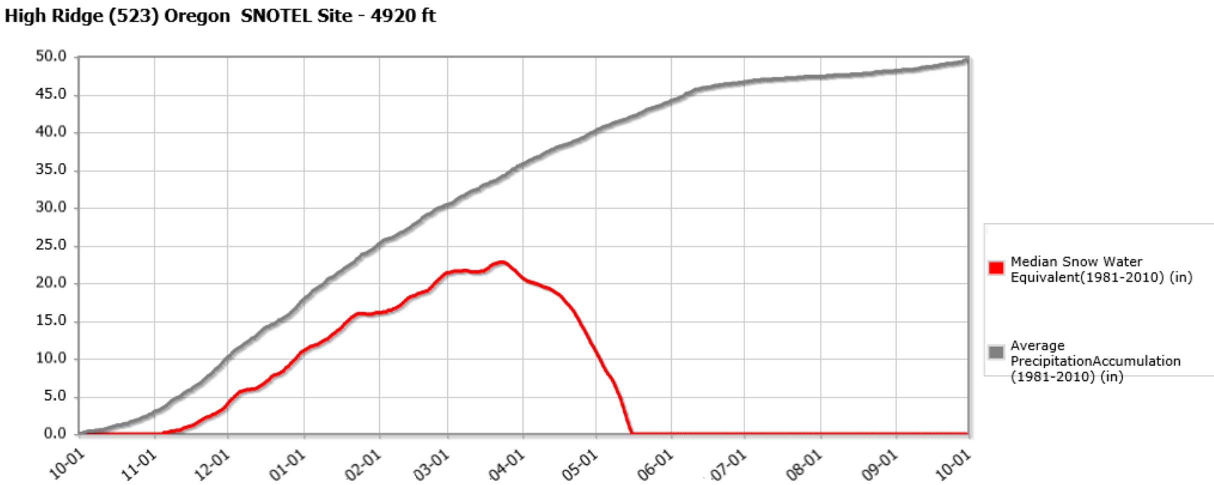

Figure 2. High Ridge SNOTEL annual precipitation and snow accumulation (NRCS 2015)

Geology and Topography

The project area is located in the northern part of the Blue Mountains Section of the Middle Rocky Mountain Steppe Province and borders the Columbia Basin Section. The project area is geologically fairly simple. Basalt flows of the Miocene age (15-17 Ma) Columbia River Group are found over the entire area. The most prominent formation is Grande Ronde Basalt. Younger Quaternary alluvial fan deposits and valley fill deposits occur in the Phillips Creek and Dry Creek drainages. Late Tertiary faults course through the area, most trending from northwest to southeast.

Topography of the analysis area is characterized by uplifted basalt plateaus and dissected canyons with moderate to steep sideslopes and narrow depositional valley bottoms. Overall, about half of the area is composed of slopes greater than 35%, with less than 10% of the area containing slope gradients greater than 60%. Elevations in Thomas Creek Project area range from about 3,200 feet where Phillips Creek leaves NSF lands to about 5,000 feet along Nine Mile Ridge. The majority of the project area occurs within the Grande Ronde River system and drains to the south and southeast via Dry Creek and Phillips Creek. The northern and western portions of the project area drain to the Umatilla River system via Thomas Creek and Spring Creek tributaries.

Recharge to the basalt aquifers occur primarily from higher elevations in the Blue Mountains, where precipitation is highest, and where permeable interflow zones are exposed at the surface by the tilting of the geologic layers. Recharge to the basalt aquifer is very slow and takes many years to reach the lower Umatilla Subbasin. OWRD sampled groundwater in the basalt and found that groundwater is youngest near the Blue Mountains and oldest adjacent to the Columbia River. Dates were reported as young as 2,570 years in Pendleton and as high as 27,250 years in the lower Sub-Basin (Umatilla County 2008).

Resource Indicators and Measures

Water Quality and Beneficial Uses

Congress has designated the State of Oregon as having responsibility to implement the Clean Water Act (CWA). The Clean Water Act requires that water quality standards be developed to protect beneficial uses and a list be developed of water quality impaired streams (303d list). When water quality standards are not met the CWA further requires development of Total Maximum Daily Loads (TMDL) for the pollutants (calculated pollutant amounts or surrogate criteria that a water body can receive and still meet Oregon water quality standards). Water Quality Management Plans (WQMPs) are developed during the TMDL process to identify measures to improve water quality.

Water quality standards are on ODEQ's website and are updated throughout the year:
http://www.deq.state.or.us/wq/standards/standards.htm

The 2010 DEQ Water Quality Assessment Database was queried to identify the resource indicators in Table 2. The 2012 Integrated Report and 303(d) list has been submitted to EPA. Until approval by EPA, the 2010 list is still in effect:
http://www.deq.state.or.us/wq/assessment/assessment.htm

Beneficial use designations are also on ODEQ's website:
Grande Ronde Basin OAR 340-41-151 tables and figures
Umatilla Basin OAR 340-41-310 tables and figures
http://www.deq.state.or.us/wq/rules/div041tblsfigs.htm#t1

The Forest Service's responsibilities under the Clean Water Act are defined in a Memorandum of Understanding between Oregon Department of Environmental Quality and the Forest Service (USDA and ODEQ 2014). The MOU designates the Forest Service as the management agency responsible for meeting the Clean Water Act on NFS lands and recognizes best management practices (BMPs) as the primary mechanism to control nonpoint source pollution on NFS lands. There is further recognition that BMPs are developed by the Forest Service as part of the planning process and includes a commitment by the US Forest Service to meet or exceed standards.

Water Quality Management Plans (WQMP) covering US Forest Service lands are in place in the Upper Grande Ronde Sub-Basin and the Umatilla River Basin. Forestry WQMPs rely on current laws, management plans, and Best Management Practices (BMPs) to provide the basis for improving water quality in the forested landscape. All federal land management activities must follow standards and guidelines (S&Gs) found in the Umatilla National Forest Plan, as amended by PACFISH (USFS-BLM 1995), and BMPs as defined in the Implementation Plan for CWA Section 208 (Water Pollution Control Act, PL 92-500, as amended). PACFISH provides management direction in the form of interim Riparian Habitat Conservation Areas (RHCAs) and associated standards and guidelines.

WQMPs for these basins expect current policies, regulations, BMPs, and adaptive management techniques to minimize pollutants from forestry related activities. Habitat conditions are expected to be improved through implementation of BMPs developed for the sedimentation and temperature TMDLs which promote riparian conditions that improve channel stability and reduce erosion and promote the protection and recovery of channel morphology to the most stable forms.

Antidegradation Policy

The purpose of ODEQ's Antidegradation Policy is to guide decisions that affect water quality to prevent further degradation from new or increased point and nonpoint sources of pollution is prevented, and to protect, maintain, and enhance existing surface water quality to ensure the full protection of all existing beneficial uses. The policy prohibits degradation of water quality in some circumstances and provides for exceptions in others. Key elements related to this project include:

- Insignificant temperature increases authorized under OAR 340-041-0028(11) and (12) are not considered a reduction in water quality (see Table 7)
- Exemptions to the Antidegradation Requirement. Some activities may, on a short term* basis, cause temporary water quality degradation. However, these same activities may also have substantial and desirable environmental benefits. Such activities and situations remain subject to water quality standards, and must demonstrate that they have minimized adverse effects to threatened and endangered species in order to be exempt from the antidegradation review under this rule:
    - Riparian Restoration Activities. Activities that are intended to restore the geomorphology or riparian vegetation of a water body, or control invasive species need not undergo an antidegradation review so long as the Department determines that there is a net ecological benefit to the restoration activity. Reasonable measures that are consistent with the restoration objectives for the water body must be used to minimize the degradation

*Note that 'short-term' means a temporary disturbance of six months or less when water quality standards may be violated briefly but not of sufficient duration to cause acute or chronic effects on beneficial uses.

Longer term temporary degradation, such as riparian conifer thinning (which may temporarily impact shade) to favor cottonwood and alder/willow, may require a letter of conditional approval from ODEQ. The Forest Service Region 6 has received a letter of conditional approval from ODEQ in support of the Northwest Forest Plan Temperature TMDL Strategy (ODEQ 2005). The Strategy was updated in 2012 (USFS 2012) and there is no letter of conditional approval for this version. The Umatilla National Forest is not covered by the Northwest Forest Plan; however, the Thomas Creek Project proposes to use the Strategy to address shade in RHCAs. Prior to project implementation, the Forest Service would consult with ODEQ and obtain a letter of conditional approval (if needed) or modify the project if a letter of conditional approval is denied.

Water Quality and Beneficial Use Support Summary

Oregon's 2010 Integrated Report and 303(d) list are available for review online at http://www.deq.state.or.us/wq/assessment/2010Report.htm. (ODEQ submitted the 2012 list to EPA for approval in November 2014 and is awaiting approval). Refer to ODEQ (2011) for a description of their assessment process. EPA recognizes 5 assessment categories. All uses are supported in Category 1 (ODEQ does not use this category). Category 2 waters have some uses supported and the water quality standard is attained. Category 3 waters have insufficient data to determine if uses are attained or not attained. Water quality limited streams are assigned category 4 or 5. Category 4 has 3 subcategories: 4A – TMDL that will address water quality standards is approved; 4B – other pollution requirements are expected to attain water quality standards; 4C – impairment not caused by a pollutant. Category 5 water bodies are water quality limited and require a TMDL and these streams are placed on the 303(d) list. The primary pollutants of concern from the Thomas Creek Project are sediment and temperature. Where relevant to this project, this report summarizes water body specific data collected by the Forest Service.

Temperature and Shade

Shade is the shadow of solid objects which block sunlight from reaching stream surfaces. By reducing the amount of sunlight reaching stream surfaces, shade reduces the increase of temperatures caused by direct solar radiation. Stream temperatures reach maximum in late July-early August when flows are low and air temperatures are highest. Factors contributing to variability include climate conditions, watershed characteristics, and streamside management. Oregon's temperature water quality standards for the protection of salmonids are summarized in Table 6 (ODEQ 2015). The temperature standard sets a 7 day average maximum temperature (7DAMT). Values greater than the standard are considered to limit the beneficial uses of salmonids during the summer time period. These criteria apply to the named streams, as well as unnamed tributaries.

Table 6: ODEQ fish use designations and 7-day average maximum water quality standards

Stream	Temperature Criteria	Other Criteria
Thomas Creek[1]	12°C (53.6°F)	-- Summer 7DAMT that are colder than the biologically based criteria may not be warmed by more than 0.3 °C (0.5 °F) above the colder water ambient temperature. -- A waterbody that only exceeds the numeric criteria when the exceedance is attributed to daily maximum air temperature that exceed the 90th percentile of annual maximum 7-day average maximum air temperatures calculated using at least 10 years data will not be in violation. -- Stream temperatures that exceed the standard during streamflows that are less than the 7-day 10-year (7Q10) low flow condition will not be in violation.
Spring Creek[1]	12°C (53.6°F)	
Dry Creek[2]	18°C (64.4°F)	
Finley Creek[2]	18°C (64.4°F)	
Phillips Creek[2]	18°C (64.4°F)	
East Phillips Creek[2]	18°C (64.4°F)	
[1] bull trout spawning/rearing-Figure 310A; [2] salmon-trout rearing/migration-Figure 151A		

Based on data collected during 1993, ODEQ has determined that upper Phillips Creek (river mile 10.4 – 14.5) and East Phillips Creek (River Mile 0 – 5.9) are attaining beneficial uses for salmonid rearing and anadromous fish migration. Table 7 summarizes continuous recording thermograph data collected within and downstream of the project area.

Table 7: Continuous recording thermograph data summary (7-day average maximum)

Stream	Location	Years	Range (°F)	Source
Phillips Creek	FS boundary	2004-2015	58 - 63	FS
	Upper and Lower	1993	55	ODFW
	Upper 2 miles (6 sites)	1993	52 - 59	ODF
East Phillips Creek	Above mouth	1986, 1988, 2006-2015	56 - 66	FS
	Upper	1993	54 - 57	ODF
Thomas Creek	At mouth	2006	66	PIBO
Spring Creek	At mouth	1992-2004	62 - 67	FS

Instantaneous 'grab' temperatures have also been collected from streams within and downstream of the project area. Temperatures in Spring Creek ranged from 50 – 58 °F (40 samples) during the August 2013 stream survey (USFS 2013a). Temperatures in Thomas Creek ranged from 52 – 63 °F (23 samples) during the August 2013 stream survey (USFS 2013b). Table 8 summarizes data collected during field reconnaissance in 2014. Phillips Creek is characterized by discontinuous flow during the summer. The 1994 stream survey reported about 30% of the lower 5 miles had surface flow and about 60% of the upper 5 miles had surface flow in late July. During the 2015 stream survey, the lower reach was about 75% surface flow and the upper reach was had 45% surface flow in late June. The SNOTEL site at High

Ridge indicated that 1994 had a near normal snowpack and 2015 had a lower than normal snowpack, although the overall Oct – June precipitation was higher in 2015.

In 1993, Andrus (Andrus and Middel 2003, GRMW 2002) placed thermographs at 6 locations in the upper 2 miles of Phillips Creek and found the temperature cooled about 7°F as the stream flowed through an 800 foot wide clearcut unit in 1991, due to numerous springs. East Phillips Creek maintains perennial flow and the 1994 stream survey reported numerous springs occurred about mid-reach. Dry Creek is an intermittent stream, with about one mile of surface flow. Finley Creek is an intermittent stream and was flowing a couple hundred feet from its mouth, then dry to the headwaters in 2014. In 2014, Thomas Creek flowed perennial below the confluence with Spring Creek and had isolated wetted segments upstream along FR32 and perennial flow in several headwater tributaries. Spring Creek maintains perennial flow, but the tributary in the project area has a discontinuous flow regime.

Table 8: Instantaneous water temperature data summary - 2014

Stream	Location	Date	Range (°F)	Source
Phillips Creek	3 sites	8/20/14	54 - 59	FS
East Phillips Creek	Above FR 3480 culvert	8/20/14	59	FS
Dry Creek	6 sites	Aug, 2014	50 – 59	FS
Finley Creek	Above FR 32culvert	8/06/14	59	FS
Thomas Creek	3 sites	8/01/14	55 – 59	FS
Spring Creek	At mouth	8/01/14	59	FS

The Upper Grande Ronde and Umatilla Temperature TMDLs incorporate measures other than daily loads to fulfill Section 303(d) requirements. These TMDLs use shade as a surrogate. The load allocations are translated to effective shade and channel width objectives. Shade was modelled at levels produced at site potential conditions as described by Crowe and Clausnitzer (1997).

The Umatilla TMDL allocates all thermal loading in Umatilla streams to natural sources, there is no allowance for increases due to anthropogenic activities. Surrogate measures have been developed to guide improvement in water temperatures, percent effective shade and "near stream disturbance zone width", channel width-to-depth ratios, and maintenance of instream flows. The TMDL provides a shade curve in Figure 38 based on near stream disturbance zone (NSDZ) width while the Grande Ronde TMDL provides a shade curve in Figure 8 based on channel width. These shade goals are based on late seral hardwood and conifer overstories to attain site potential effective shade levels and are also dependent on stream channel orientation (Table 9).

Table 9: Upper Grande Ronde and Umatilla TMDL effective potential shade for streams < 30 feet wide

Stream Orientation	UGR	UMA		
	Zone 2 (< 4,800 ft)	NSDZ=10 ft	NSDZ=75 ft	NSDZ=150 ft
N - S, S - N	80%	92%	66%	42%
NE - SW, SW - NE	83%	92%	62%	38%
E - W, W –E	92%	92%	75%	28%

The Umatilla TMDL also uses the bankfull channel width/depth ratio as a surrogate for temperature (Table 10). Narrower and deeper channels provide less opportunity for solar heating and allow more opportunity for water retention and subsurface mixing in the cooler hyporheic zone.

Table 10: Umatilla TMDL Width/Depth Ratio Targets

Rosgen Channel Type:	A	B	C
TMDL W/D Target:	7	17	24
(Dominant Range)	(3-12)	(12-20)	(10-36)

The Umatilla Total Maximum Daily Load identified near-stream vegetation disturbance and removal as sources of thermal pollution (*i.e.* increased stream temperature above the natural background levels) by increasing the amount of solar radiation reaching the stream surface (ODEQ 2001). The Total Maximum Daily Load process identified restoration of riparian areas as a major objective for improving stream temperature and reducing sediment production in the Umatilla Basin. Overwidened channels are expected to become narrower as riparian vegetation stabilizes the banks and begin to capture suspended and bedload materials

Sedimentation

Sources of sediment include hillslope and channel erosion and the road network. Sediment mobilized from hillslopes and roads may be stored in channels for years or delivered into a stream within a season depending on precipitation patterns. Suspended sediment yield measured in the High Ridge Evaluation Area of the Umatilla Barometer Watershed (adjacent to the northeast of the project) had a 12-year (1984-95) average annual yield of 18 tons/mi^2 (range 3 – 43) for the control (unlogged) catchment, with high inter-annual variability (Helvey and Fowler 1995). Monitoring sedimentation downstream in the Umatilla River and North and South Forks indicated that much of the annual sedimentation was generated from only a few, large runoff events (Harris and Clifton 1999). Sediment transport during spring snowmelt was the dominant transport process, although rain-on-snow events produced some of the largest single event volumes.

ODEQ has identified sediment as a pollutant in TMDLs, however there is currently no numeric standard or administrative rule specific to sediment. The statewide narrative criteria describes “the formation of appreciable bottom or sludge deposits or the formation of any organic or inorganic deposits deleterious to fish or other aquatic life or injurious to public health, recreation, or industry may not be allowed”.

The TMDL approach to sedimentation includes strategies to reduce total suspended solids (TSS) and turbidity. The Umatilla TMDL uses a site-specific stream potential for these attributes and monitors them through time. Restoration activities are directed first at changes in management which identifiably causes existing problems and active restoration where relevant criteria can benefit.

Fine sediment is detrimental to aquatic life through in-filling salmon and trout spawning gravels and water column abrasiveness and opacity. The sediment standard uses a narrative, rather than numeric criteria. ODEQ’s water quality assessment methodologies have used stream specific documentation that showed excessive sedimentation was a significant limitation to fish or other aquatic life. This included information indicating beneficial uses impairment (aquatic community status, bio monitoring reference sites, or fishery data) and measurement data for benchmarks such as cobble embeddedness or percent fines (ODEQ 2010). ODEQ is currently reviewing approaches to apply a numeric benchmark based on measurements of stream conditions to implement the narrative criteria.

Sediment TMDLs (turbidity and suspended solids) were established by modeling. Based on this work, the upper Umatilla watershed was not assigned any reduction in sedimentation to meet load allocations. This analysis indicates that upper forested watersheds contribute minimally to turbidity and the in-stream load of sediment. However, the water Quality Management Plans (WQMP) recognizes that some forest management practices such as poorly located roads or excessive ground disturbance during harvest can lead to increased sedimentation. In addition naturally occurring events on forest landscapes such as wild fires and landslides can also lead to increased sedimentation.

The Umatilla TMDL provides sediment erosion load allocations expressed as uplands and streambank percent reductions for individual watersheds. Thomas Creek and Spring Creek occur in what the TMDL refers to as "Forks" or "Upper Umatilla" watershed (Figure 47 of the TMDL). The reductions are based on total suspended sediment loading (TSS) during a design storm with a discharge of 1.5 times the bankfull flow of the Umatilla River below Pendleton. The Upper Umatilla Watershed was assigned a TSS of 76 mg/L loading capacity (at 30 NTU) and the TMDL indicated no load reduction was needed.

The Upper Grande Ronde TMDL discusses sedimentation and turbidity together and derived the following basinwide target (same as the Umatilla basin-wide target):

- TSS: 80 mg/L
- Turbidity: 30 NTU

Water quality parameters are often interrelated and this is obvious in the Grande Ronde TMDL (UGR TMDL) which found that high fine sediment distributions in the Upper Grande Ronde Subbasin correlated with non-woody riparian vegetation conditions and sedimentation will be greatly reduced as a result of the bank stability and filtering improvements that will result from the riparian vegetation improvements necessary to meet the shade surrogate allocation. The TMDL stated that the load allocations provided to address temperature, pH, dissolved oxygen standard violations, coupled with ongoing efforts by the U.S. Forest Service to reduce loads from roads and other sources, will be adequate to address sedimentation and turbidity concerns in the UGR Subbasin.

Roads and Sediment

The effects of roads on water quality and quantity have been studied for decades. Gucinski et al (2001) summarized road-related scientific information and the reader is referenced to that document for more detail. Road density is used as an indicator of potential for affects to hydrologic function (extension of the stream network) and water quality (sediment delivery to surface waters). Stream crossings are used as an indicator of the degree of connectivity between the road system and the drainage network. To the degree that roads are connected to the drainage network the risk of road sediment reaching surface waters is increased, the drainage network is lengthened and the potential for precipitation to drain more quickly, with less residence time in the watershed is increased.

Roads have the potential to intercept surface and subsurface water, reducing infiltration and increasing the delivery of water to channels. Sedimentation may be increased by surface erosion from roads and the ability of road drainage to route sediment to channels. The GIS database indicates that approximately 30 miles of road have been closed and decommissioned since the 1990s.

The road system within the four subwatersheds of the analysis area contains about 219 miles of open, closed and decommissioned routes (Table 11). Routes on FS lands include 8 miles of maintenance level (ML) 5 roads, 2.5 miles of ML 4 roads, 3.5 miles of ML 3 roads, 4 miles of ML 2 roads and 112 miles of ML 1 (closed) roads. The MVUM database shows about 30 miles of decommissioned roads, however, some roads that were decommissioned are no longer in the database. Decommissioning generally involved removing drainage structures, installing dips and water bars, maybe surface scarification and seeding and blocking vehicle access to allow revegetation. Many of these routes have been successfully closed to motor vehicles. Motorized ATV trails (vehicles < 50" side) have been designated on 27.4 miles of closed roads and 11.5 miles of decommissioned roads.

Table 11: Road Density on NFS Lands

SWS Name	SWS (mi^2)	Road Miles All[1]	Road Density (mi/mi^2)	Road Miles w/o Decom Roads	Road Density (mi/mi^2)	Stream- Road Intersections
Dry Creek	11.2	38	3.4	28	2.6	108
Phillips Creek	27.2	118	4.3	98	3.6	229
Thomas Creek	19.3	63	3.3	37	3.2	88
		219				425

[1]Includes open, closed and decommissioned roads

The major system roads into Thomas Creek (FR32), Dry Creek (FR32) and Phillips Creek (FR3738) are located parallel to the stream channels. Due to the narrow valley bottom and orientation, the roads reduce shade and increase sedimentation. Crabtree (1999) demonstrated a significant statistical difference between cobble embeddedness of least managed and most managed subwatersheds in the Umatilla and Meacham Ecosystem Analysis area. Cobble embeddedness is the degree that larger particles (boulder, cobble, gravel) are surrounded or covered by fine sediment (not defined, but probably sand-sized particles or smaller than 2 mm). Substrate was considered embedded if > 35% coverage of larger particles by fine sediments. He also found a relatively good correlation between subwatershed road density and cobble embeddedness, suggesting that road density management will continue to be an important management consideration.

FR3738 and FR3148010 were last maintained during the Pedro-Colt Timber Sale, which ended in 2008. FR3738 parallels Phillips Creek for about 9 miles, however travel distances from the cross drain culverts allow much of the road-derived sediment to infiltrate or filter across vegetation before entering the floodplain or channel. About 3 miles of FR32 closely parallels Dry Creek and will continue to be a longstanding sediment source due to close proximity to the stream with little vegetated buffer between the cross drain culvert outlets and stream channel. About 35% of the road crossings are on native surface roads and most of these (133 of 148) occur on class IV streams.

Biological Criteria

The biological criteria standard uses biological community (macro invertebrate) assessments as an indicator for aquatic life beneficial use support. DEQ's protocol is based on biological assemblage information for freshwater macroinvertebrates collected by DEQ at reference sites throughout Oregon. DEQ identifies sites in a given region that are least disturbed by anthropogenic activities and uses these as reference sites. Thomas Creek was assessed for and is attaining the biological criteria. ODEQ has not identified water quality issues related to biological criteria for other streams in the project area and there are no other known data for streams within the project area.

PACFISH/INFISH Biological Opinion (PIBO) monitoring included one macroinvertebrate site on Thomas Creek, about 4 miles downstream of the project boundary (Table 12). Water quality indices indicate fair to good water quality. Eric Archer (PIBO Program Lead, personal communication April 15, 2015) related that the RIVPACS metric is a more robust indicator of stream health. ODEQ data are based on sampling in 2001 and the most recent data indicate overall good water quality in Thomas Creek based on macroinvertebrate assemblages.

Table 12: PIBO Macroinvertebrate Sampling from Thomas Creek

	CTOq	RIVPACS

2001	69	0.73
2006	65	0.58
2011	68	0.87

CTOq – USFS Community Tolerance Quotient – dominance weighted, ranges from 20 (unpolluted water) to 100 (severely polluted)

RIVPACS - compares the number of taxa expected in high quality habitat to the number observed at a site. Ranges from 1 (no difference between observed and expected) to 0 (none of the expected taxa were observed). Scores > 0.78 indicate good quality habitat whereas scores < 0.78 indicate poorer quality habitat.

Water Yield and Peak Flow

The mapped stream system in the Thomas Creek Project area includes 15 miles of perennial streams, 108 miles of intermittent streams and 12 miles of streams with a discontinuous flow regime. These streams represent the channeled system. The project area also contains numerous unchanneled colluvial hollows or ephemeral swales, which have not been mapped.

Peak streamflows vary depending on winter and spring weather conditions. There are two general hydrograph types within the project area: a snowmelt-dominated hydrograph where peak streamflow results from normal spring runoff and a winter-dominated hydrograph where peak flows occur between November and February as a result of rain-on-snow. Rain-on-snow zones typically occur between elevations of 3,000 to 4,000 feet.

Changes in forested stand and canopy density caused by harvest, fire, or insect and disease can change the distribution of the snow pack, increase the rate of melt of the snow pack, and cause the timing of the melt to be earlier. These factors may lead to changes in peakflows. In addition, reduction of stocking density reduces the overall vegetative use of water, increasing the amount of water available for runoff. Changes in water yield and in peak flows have the potential to destabilize channels, causing increased erosion and sedimentation in channels.

The U.S. Geological Survey measures stream flows on the Umatilla River at Gibbon and on the Grande Ronde River at Rondowa below the confluence with the Wallowa River. Flows are heavily dependent on winter snowpack (Umatilla County 2008). The annual distribution of flows is typical of a snowmelt-dominated system, with the greatest percentage of runoff occurring from April to June. High flow years include 1964 and 1996. High flows in February 1996 were the recorded maximum at many gages in northeastern Oregon. Effects from high flows included channel and floodplain scour, deposition, and transport of large woody debris (Clifton et al, 1999).

At the High Ridge SNOTEL site, the 30-year average peak snowpack (as snow water equivalent) occurs around March 24. Helvey and Fowler (1995) reported that peak flow occurred on May 23 from the control watershed at the High Ridge Evaluation Area. Peak flows further downstream on the South Fork Umatilla River occurred, on average, around April 20-May 04 (USFS data 1987-97). The modelled hydrograph for Thomas Creek shows that April is highest flow month (OWRD 2015a). Figure 3 displays the 50% (flows are exceeded 50% of the time) and 80% exceedance hydrographs for Thomas Creek.

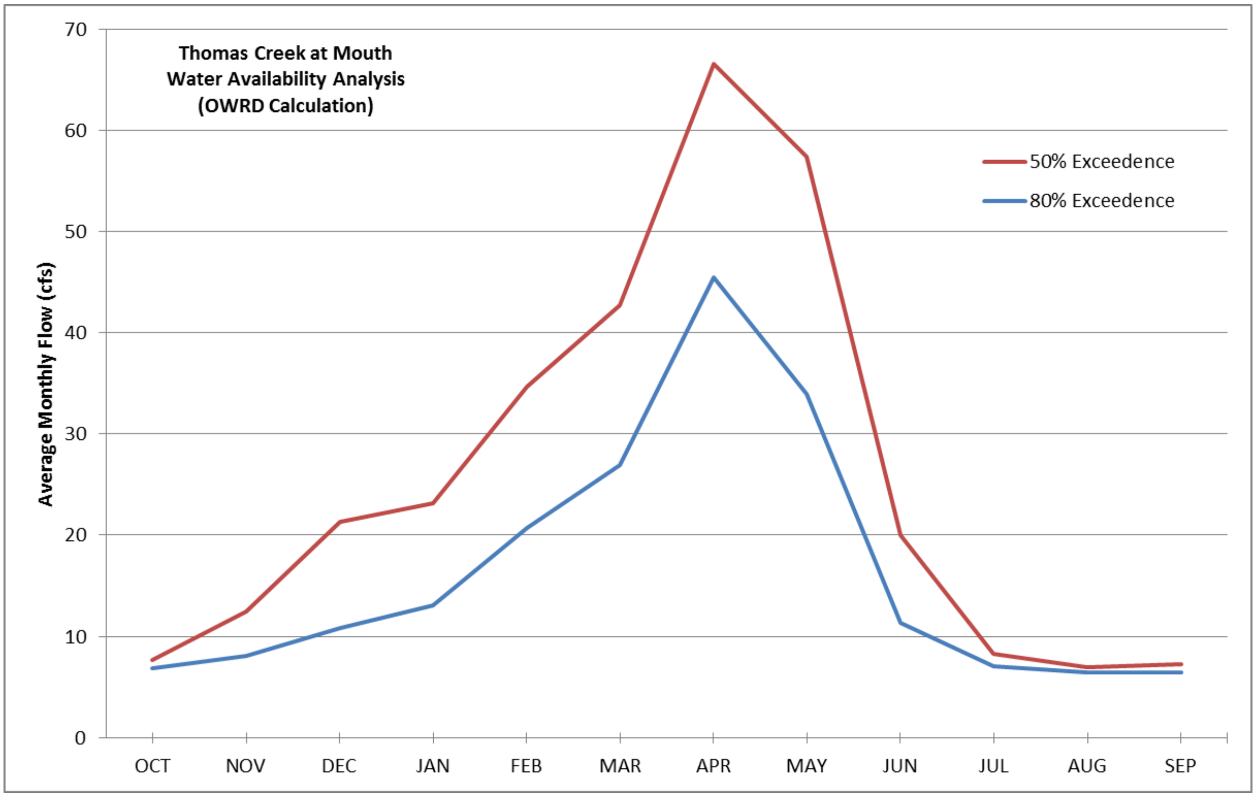

Figure 3. Thomas Creek hydrograph

Streamflow duration, especially of intermittent streams such as Phillips Creek and Dry Creek are more dependent on snowpack than streams such as Thomas Creek and Spring Creek, which have a groundwater component that maintains baseflow in lower reaches. Hydrographs for Phillips Creek derived from OWRD's water availability analysis report indicates that that in drier years Phillips Creek flows tend to peak earlier (Figure 4).

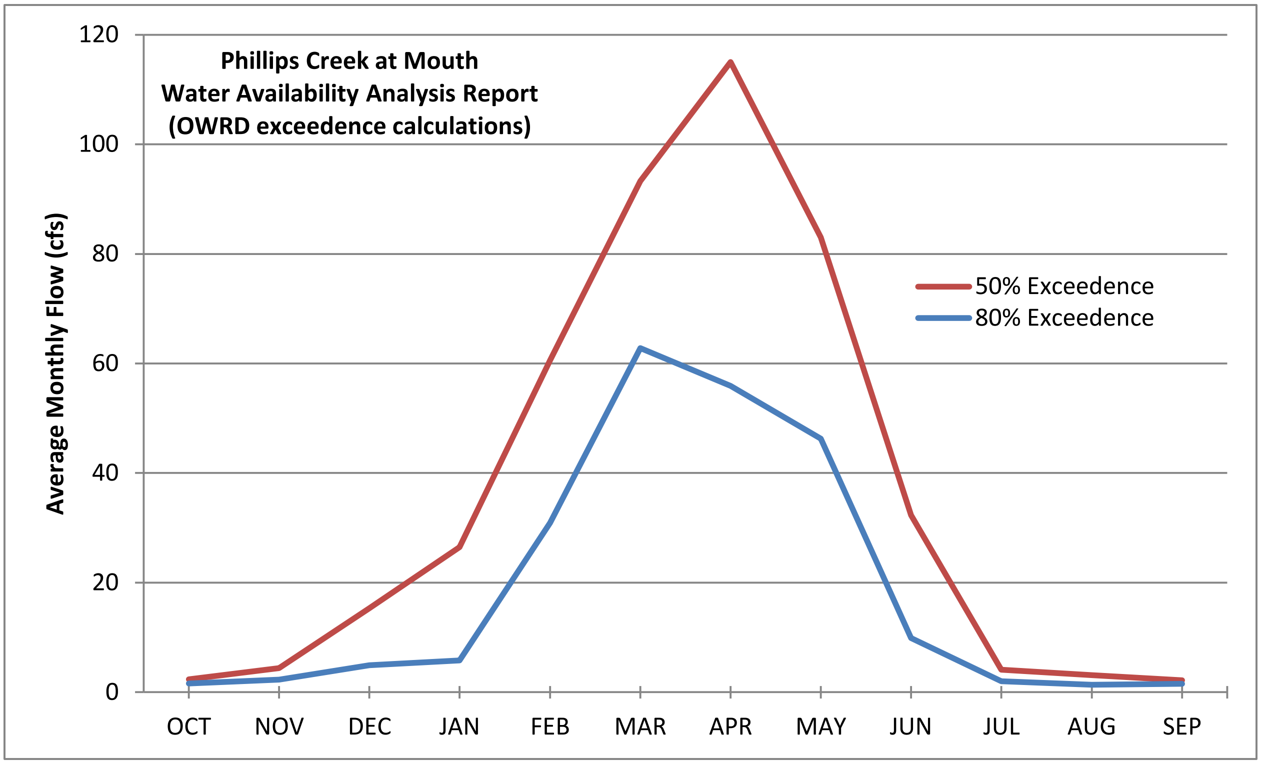

Figure 4. Phillips Creek hydrograph

Table 19 shows the bankfull flow (Q_2) flow and 100-year flood (Q_{100}) estimates calculated using the regional equations (OWRD 2015b). Q_2 is the flow that has a 50% chance of being equaled or exceeded in any year and Q_{100} has 1% chance. (Bankfull is based on flood frequency analysis and is actually more in the range of 1.5 to 1.8 year return interval, but Q_2 was readily available and will be used for this analysis). The bankfull discharge is the flow at which a stream generally has enough power to transport larger sediment particles (d_{50} and larger) and is also the flow which tends to maintain a channel's shape and generally do not alter stream morphology (Dunne and Leopold 1978). Larger flows, such as the Q_{100} can transport much higher amounts of sediment, but tend to be shorter lived. These flows can also cause adverse channel adjustments and move large woody debris. When adjusted for drainage area (cfs/mi^2), Table 13 shows that the Thomas/Spring subwatershed is capable of yielding about 50% or more water per unit area than the Phillips and Dry Creek subwatersheds.

Table 13: Bankfull and peak streamflow

Stream	D.A. (mi^2)	Q_2 (cfs)	cfs/mi^2	Q_{100} (cfs)
Dry Ck/Finley Creek	8.0	105	13.1	393
Dry Creek at mouth	40.3	355	8.8	1300
Phillips Creek at FS	18.0	193	10.7	714
Phillips Creek at mouth	38.9	346	8.9	1260
Thomas Creek ab. Spring Ck	6.5	126	19.4	468
Spring Creek	8.6	151	17.6	580
Thomas Creek at mouth	19.2	294	15.3	1110
S.F. Umatilla above Buck Ck	47.3	592	12.5	2230
High Ridge WS 1	0.1	---	1.1	---
High Ridge WS 2	0.1	---	1.5	---
High Ridge WS 3 (control)	0.5	---	1.6	---

High Ridge WS 4	0.2	---	1.4	---

Dry, Phillips, Thomas, Spring Creeks and SF Umatilla River from OWRD web site;
High Ridge from USFS gauge data

Roads and Water Yield

Roads have the potential to intercept surface and subsurface water, reducing infiltration and speeding the delivery of water to channels. Sedimentation may be increased by surface erosion from roads and the ability of road drainage to route sediment to channels. Road density alone does not indicate slope position, another critical factor. Valley bottom roads have the most direct effect on streams and riparian areas because of accelerated erosion and loss of streamside shade. Mid-slope roads intercept subsurface runoff, extend channel networks and accelerate erosion, and ridge top roads can influence watershed hydrology by channeling flow into small headwater swales, which may accelerate channel development.

Watershed risk classes based on road density were assigned in *Determining Risk of Cumulative Watershed Effects Resulting from Multiple Activities* (McCammon 1993). For watersheds with relief < 30%, road density < 3 mi/mi^2 are low risk, 3.1 – 4.5 are medium risk and > 4.5 are high risk. The values in Table 14 are meant as a guide to assess the potential of road impacts (discussed previously) to adversely affecting hydrological function and water quality. Road densities are shown with and without decommissioned roads because decommissioning covers a range of practices that may or not remove the road template.

Table 14: Road density for NFS lands

SWS	Road Density (mi/mi^2)		Basin Relief (FS)
	All Roads	w/o Decom	
Dry Creek	3.4	2.6	5%
Phillips Creek	4.3	3.6	4.5%
Thomas Creek	3.3	3.2	5.5%

Equivalent Treatment Area

The effect of road surfaces and past harvest on water yield and the timing of flows are analyzed using the Umatilla NF Equivalent Clearcut Area (ECA) methodology (Ager and Clifton 2005). An equivalent treatment acre (ETA) computer program was developed to simplify use of the model. The NRIS database was used to determine past acres harvested, harvest prescriptions, and year of harvest through 2015 and these values were entered into the model. McCammon (1993) assigned risk to watersheds from changes in cover and evapotranspiration as low (< 15%), moderate (15 – 30%) and high (> 30%). Using the ETA threshold for cumulative effects, ETAs for the existing condition are low and are due mainly to the effects of road surfaces (Table 15).

Table 15: Equivalent Treatment Area

Subwatershed	ETA
Dry Creek	2.3%
Phillips Creek	2.8%
Thomas Creek	1.5%

Riparian Condition

Channel Morphology

Interim RMOs (see Table 31) were established as a baseline guide for describing good habitat for anadromous fish for 3rd to 7th order streams at the watershed (HUC5) scale. Data are summarized in Table 16 as a requirement to show compliance with interim RMO metrics. Note that RMO metrics are based on wetted width and the data in the table are based on the bankfull channel, therefore a direct assessment of compliance with interim RMOs is valid only for a stream flowing at the bankfull level. The assumption can be made that if the bankfull channel dimensions meet RMOs, then channel geomorphology is being met at all water level elevations. Based on best available science, the bankfull width/depth ration of < 10 is not desirable for all stream types. The streams shown in Table 16 are all 3rd to 5th order channels.

Table 16: Interim Riparian Management Objectives and Reported Metrics

Stream	Miles	BFW	PACFISH RMOS				Rosgen
			PF	T_w	LWD	BF W/D	
PACFISH	---	---	Varies	60/64 °F	> 20	< 10*	Type
Phillips Reach 2	4.0	36	37 (36)	63(1)	9	32	C3/B3
Phillips Reach 3	4.4	14	35 (74)	57(1)	12	27	B3
E. Phillips Reach 1	1.3	19	48 (59)	65(1)	6	25	B3
Dry Reach 1	1.7	13	2 (79)	57(2)	24	15	B4a
Dry Reach 2	2.3	10	13 (96)	59(2)	19	20	B4a
Thomas Reach 1	2.4	26	42 (46)	63(2)	18	37	F2b/F3b
Spring Reach 1	1.7	19	51 (59)	67(1)	25	19	B3a
Spring Reach 2	2.0	12	61 (84)	63(2)	22	12	B3a

highlighted = not attaining RMO; (1) continuous-recording thermographs, 7 day maximum average; (2) instantaneous grab temperatures; * PACFISH specifies wetted width/depth ratio; BFW = bankfull width (ft); PF = pool frequency (pools per mile showing measured and (RMO guide); T_W = water temperature: spawning/ migration-rearing; LWD = large woody debris; BF W/D = bankfull width-to-depth ratio

The best use of the data in Table 16 is not a comparison to PACFISH interim RMOs. To illustrate, take the North Fork Umatilla River, for example. The North Fork Umatilla River occurs near the project area and within a wilderness area, thus, the stream channel and adjacent forest have not been managed for timber harvest and there are no roads along streams. Based on the 2009 stream survey, the reaches surveyed are Rosgen ‘B’ stream types. The following data show that this stream does not meet RMOs for width/depth, large wood (2 of 3 reaches) and pool frequency, even though harvest and road building have not occurred along the stream:

Table 17: North Fork Umatilla River RMO Metrics

	Reach 01	Reach 02	Reach 03
Pool Frequency	8	14	24
Large Wood	13	29	8
BF W/D	18	13	14

Best available science indicates that the RMOs are not universally applicable. PACFISH allows RMO modifications based on local conditions and watershed analysis. Watershed analyses have been conducted for streams within the project area, however the watershed analyses did not propose to change RMOs. Stream channel shape and substrate are determined by the range of flow and sediment that the stream receives over time, for a given geographic setting (Rosgen 1996). When the amount of streamflow and sediment are highly altered, changes to the width, depth and gradient of the stream can occur.

For this analysis, the stream survey data will be used to assess stream geomorphology based on Rosgen's classification. Rosgen's (1996) stream channel classification has been widely used since the 1980s and is an accepted procedure for measuring and documenting channel features. The Rosgen stream type is an alpha-numeric system that describes the sinuosity, gradient, bankfull width/depth ratio, entrenchment and substrate of a given stream reach (Attachment 1). Rosgen also identified a central tendency of pool-to-pool spacing and acknowledged that spacing between pools is highly variable (Attachment 2).

Rosgen's system is based on the ability to consistently identify and measure the bankfull channel width and depth. Most stream surveys are conducted during the summer and generally represent low flow conditions, therefore bankfull measurements are based on interpretation of field indicators. Interpretation of data for this analysis is based on stream survey data collected in the field (width, depth, entrenchment, substrate), office calculations (channel gradient and sinuosity), aerial photo interpretations and professional judgement based on more than 20 years of measuring and interpreting channel features). Field reconnaissance by the District hydrologist in 2014 included observations of fluvial processes (channel incision, floodplain elevation, meander patters, substrate) and spot measurements of bankfull width and depth at random locations along the main stream channels.

Region 6 Level II stream inventory data presented in Tables 23 to 26 summarize measurements and observations relevant to describing Rosgen stream channel type. Stream survey protocols have evolved during the course of the past 20+ years and the data may not be directly comparable, however, these are the best available data. Rosgen's method requires bankfull measurements to be taken at riffle sections. Survey protocol prior to 1993 was to record bankfull measurements from pool tail crests, therefore, these data are not comparable. Also, streambank stability was not part of the protocol in earlier surveys. Substrate material were ocular estimates of bed and bank materials broken out separately in the earlier surveys and are now measured using the pebble count procedure for the bankfull channel width.

Historically, trees were removed from riparian areas during road construction and until the 1990s, timber harvest from riparian zones was a common practice on the Umatilla National Forest. Stream cleaning to enhance fish passage was also a common activity. These practices have resulted in the direct removal of large woody debris and lowered recruitment rates. Large woody debris in streams enhances fish habitat, forms pools and retains sediment and organic matter and creates large structural roughness elements that help dissipate energies associated with high stream flows (Bisson et al 1994). The presence of pool-forming wood is highly correlated with geomorphic factors (Richmond and Fausch 1995). Davidson and Eaton (2013) noted that wood jams also generally increase water stage, thereby promoting floodplain connectivity through avulsion. Rosgen notes that LWD changes slope, affects potential and kinetic energy, shifts boundary shear stress, creates extremes of velocity, and directly influences sediment storage. Depending on stream type, addition of woody material can enhance or degrade habitat.

Phillips Creek and East Phillips Creek

Phillips Creek is characterized by intermittent or discontinuous flow in the lower reach (5-6 miles) and perennial flow in the upper 2-3 miles on NFS lands. Herbst (2002) indicated that prior to the 1960s Phillips Creek reportedly maintained perennial flow during some years. Table 18 summarizes key morphologic data collected during the stream surveys. In general, data indicate that the stream types identified in the table are appropriate for the landscape setting. Reach 2 (forest boundary to East Phillips Creek) occurs primarily as a Rosgen C type, typified by a meandering pattern with point bars. Reach 03 is steeper and straighter, more confined with a riffle-pool morphology characteristic of a type B channel. Comparing 1994 and 2015 data indicate that pool frequency has increased about 30% in both reaches.

The reach 02 channel is deeper by about 30% while the reach 03 channel has become wider and shallower by about 30%.

Table 18: Summary of channel morphology data for Phillips and East Phillips Creeks

Reach	BFW	BF W/D	E	G	S	Substrate	Stream Type	Pools/mi	LWD/mi	Bank Stability
Phillips Creek - 2015										
2	36.5	31.5	2.6	2		CO-60%/GR-30%	C3/B3	36 (21-29)	9	97%
3	14.2	26.9	2.1	4	1.04	CO-47%/GR-38%	B3	35 (93-124)	12	99%
Phillips Creek - 1994										
2	34.6	45.4	M	2	1.05	Bed-CO/GR Bank-GR/GR	B3/C3	24 (21-31)	15	---
3	11.3	19.4	M	6	1.1	Bed-GR/CO Bank-SA/GR	B4a	21 (117-155)	12	---
East Phillips Creek – 2015										
1	19	24.7	--	3	1.02	CO-45%/GR-37%	B3	48 (69-93)	6	99%
East Phillips Creek – 1994										
1	17.5	22.1	--	3	1.02	Bed-CO/GR Bank-CO/GR	B3	48 (75-100)	25	---

BFW=bankfull width; W/D=width to depth ratio; E=entrenchment ratio-M=moderate; G=% gradient; S=sinuosity; Substrate: BO=boulder; CO=cobble; GR=gravel; SA=sand; Stream Type=Rosgen ; Pools/mi- top number is from survey and bottom number is based on Rosgen

Analysis of 2014 aerial photos, in addition to field review and limited measurements in 2014 indicate that stream type is appropriate for the valley form in which the channel resides. Bankfull widths range from 35-40 feet along lower portions of the reach to 15-20 feet downstream of East Phillips Creek. Reach 2 is still somewhat entrenched within the valley floor, which limits its ability to dissipate high energy associated with flood flows. Depositional patterns of bed materials and channel meanders indicate that the stream has a high bedload supply. The riparian community most resembles the black cottonwood/pacific willow and black cottonwood/mountain alder-red osier dogwood plant associations described by Crowe and Clausnitzer (1997). East Fork Phillips Creek and Glenn Canyon are supplying bedload to this reach. Single log weirs and log defelctors were placed in Phillips Creek in the 1980s. Some of these logs were installed downstream of culverts, probably to reduce scour and some logs were installed to create pools for fish habitat.

Phillips Creek Reach 3 grades from a meandering type C channel to a confined, higher gradient A channel in the headwaters. The data in the table are summarized for the 4 mile long reach and are not representative of each channel type. About 40% of this reach was clearcut in 1991. The data indicate that pool-to-pool spacing is much lower than predicted for reach 03. Analysis of 2014 aerial photos, in addition to field review and limited measurements in 2014 indicate that stream morphology is still appropriate to the valley setting. Bankfull widths range from 15-20 feet near East Phillips Creek to 6-8 feet mid-reach to 3-4 feet upstream of the upper FR3738 crossing.

East Phillips Creek is a perennial tributary to Phillips Creek. The lower part of this reach (in Unit 129) is mostly incised within an alluvial fan deposit and occurs as both B3 and G3 channel types, which is not atypical in this setting. The stream surveys indicate that the channel is slightly wider and shallower than reported in 1994. Field observations in 2014 indicate the channel is storing a high amount of cobble-sized bedload. Much of this material was probably mobilized during the 1996 rain-on-snow event and is still working through the system. Observations also indicate that additional material is also being recruited from lateral scour as the channel meanders into to the valley fill as it slowly reclaims the valley bottom. Alder are the dominant riparian hardwood species.

Dry Creek and Finley Creek

Table 19 summarizes data for Dry Creek from surveys conducted in 1993 and 2000. Dry Creek in reach 1 and much of reach 2 is intermittent. Perennial flow occurs near the mouth of Finely Creek and along a 1 mile segment above and below FR32 crossing. Because the stream was mostly dry during the surveys, some parameters were not measured. The data show an increase in woody material and bank stability. The data also show a change from cobble-dominated substrate in 1993 to gravel-dominated in 2000. Field reconnaissance in 2014 indicates that Reach 01 is still gravel-dominated. In 1993, poor streambank conditions were attributed to sheep grazing along reach 01. Sheep grazed and trailed along Dry Creek in 2014 for about 2 weeks in August. Most of the intermittent draw bottoms to the west were heavily trailed by sheep with resultant detachment of fine sediment. This material can be easily mobilized with rainfall or snowmelt runoff. The main stem of Dry Creek is characterized by both stable B and unstable G stream types. Instability occurs predominantly where the stream is cutting through fan deposits of tributary streams to the west. FR32 occupies the east valley bottom and sideslope. Single log weirs were also placed in Dry Creek, probably in the 1980s. Some of these logs were installed downstream of culverts, probably to reduce scour and some logs were installed to create pools for fish habitat.

Table 19: Summary of channel morphology data for Dry Creek

Reach	BFW	BF W/D	E	G	S	Substrate[1]	Stream Type	Pools/mi	LWD/mi	Bank Stability
Dry Creek - 2000										
1	13.3	14.9	2.1	5	1.04	GR-76%/ CO-24%	B4a	2 (99-132)	24	100%
2	9.8	20.0	3.2	7	1.07	GR-70%/ CO-29%	B4a	13 (139-179)	19	100%
Dry Creek - 1993										
1	---	---	S	5	1.04	Bed-CO/GR Bank-GR/SA	---	---	0	Poor[2]
2	---	---	M	7	1.05	Bed-CO/GR Bank-CO/SA	---	---	2	---

[1]Substrate based on 2 pebble counts in each reach; [2] not quantified, bank sloughing due to sheep grazing

Finley Creek is an intermittent tributary to Dry Creek. It contains a short segment of perennial flow near its mouth. Field reconnaissance in 2014 found that Finley Creek occurs mostly as a Rosgen type B stream, although where valley width allows, it is meandering into the valley fill. Finley Creek is a high bedload transport stream, with the dominant source of material derived from lateral migration, rather than tributary input.

Thomas Creek and Spring Creek

Stream surveys were conducted in Thomas Creek in 1992 and 2013 (Table 20). The surveys terminated about 2 miles downstream of the project area, at the confluence with Spring Creek. Numerous rock and log structures (~167) were installed in this reach in the 1980s in an attempt to improve habitat. Survey data indicate that the stream transitioned from a Rosgen G3/G4 with low width/depth ratio and moderate entrenchment to an entrenched, overwidened F stream type. In this valley type setting the F stream type occurs under disequilibrium. F2 streams are considered to be naturally stable and F3 in the Pacific Northwest are stable when the banks are well-vegetated.

Comparing the 1992 and 2013 surveys, stream bottom substrate appears to have shifted to a larger particle size. This is usually caused by scour, which did occur in this drainage as a result of the 1995-96 runoff events. The change from low to high w/d ratio, coupled with the change from moderately entrenched to entrenched means the channel has widened and downcut. The survey data also show a reduction in natural pools and large wood in the past 20+ years. The high w/d ratio and reduction in pools indicate that some pools have filled. The reduction in wood may have been due to the high flow pushing it out of the bankfull channel, however, it also indicates a lack of recruitment in the 20 year period between surveys. Several perennial headwater tributaries of Thomas Creek originate from within the project area. Field reconnaissance upstream of the surveyed reach in 2014 indicated that bedload mobilization and transport appears to be low under current conditions.

Table 20: Summary of channel morphology data for Thomas Creek

Reach	BFW (1)	BF W/D	E	G	S	Substrate (2)	Stream Type	Pools/mi (3)	LWD/mi (4)	Bank Stability
Thomas Creek-2013										
1	25.7	36.6	1.2	3	1.04	BO-40%/ CO-40%/ GR-20%	F2b/ F3b	42 (52-69)	18	100%
Thomas Creek-1992										
1	---	10.4	M	3	1.1	Bed-CO/GR Bank-CO/GR	G3	61	38	---

(1) 1992 protocol was for BF measurements at pool tail crest; Thomas Creek 2013 – BF measured at 3 sites, lower 500 ft of reach may not be representative of entire reach (2)Substrate for 2013 is from Wolman pebble count and 1992 is an ocular estimate;(3) In 1987, 130 rock and log structures were installed; (4)LWD does not include 37 log weirs noted during surveys; substrate based on 2 pebble counts

Stream surveys were conducted in the main stem Spring Creek (Table 21). Spring Creek is a tributary to Thomas Creek and has one tributary within the project area. The differences between the 2013 and 1992 surveys are an increase in the width/depth ratio, an increase in pools and decrease in woody material (the 1992 survey did not break the stream into 2 reaches). A reduction in large wood and increase in smaller-sized particles (gravels) should lead to in-filling of pools rather than pool creation. These are large differences in width/depth ratio and pool frequency and perhaps the survey data just cannot be compared. The 2013 data indicate that the channel is stable and appropriate for the valley in which the stream resides.

Table 21: Summary of channel morphology data for Spring Creek

Reach	BFW	BF W/D	E	G	S	Substrate	Stream Type	Pools/mi	LWD/mi	Bank Stability
Spring Creek-2013										
1	18.8	18.5	1.9	5	1.02	CO-37%/ GR-35%/ BO-25%	B3a	51 (70-94)	25	100%
2	11.9	21.1	1.5	5	1.01	GR-52%/ CO-35%	B3a	44 (111-148)	22	99%
Spring Creek-1992										
1	---	9.9	M	5	1.08	Bed-CO/CO Bank-CO/GR	A3	19	43	---

2013 Substrate based on 2 pebble counts in each reach; BF measured at 3 sites middle of each reach

The Spring Creek tributary within the project area is considered a Class III stream, although the flow regime is really more discontinuous, than perennial. This reach is vertically unstable, as indicated by a headcut at the lower end of the reach, which appears to be caused by the old FR 3145 crossing. This reach also has a headcut at the upper end of the reach. Headcuts tend to move as a 'wave' in the upstream progression and cause the channel to degrade, or downcut into the valley fill. As the stream becomes incised and loses contact with the floodplain, flow is concentrated and velocities increase. The stream will continue to downcut until a more resistant layer is reached or until the sediment and water supply become balanced. For lower gradient streams, such as this one, the stream will begin to re-establish meanders into the valley fill and slowly build floodplain, but at a lower elevation. Bank stabilizing vegetation is also important in this reach. Where the overstory is more open, dense alder thickets are colonizing the stream bank. The reach still has segments of functional floodplain, however, the channel is straighter, has few pieces of large wood and is less sinuous than it is capable of achieving.

Tributaries

Tributary channels generally occur as Rosgen Type A and Aa+ types that dissect the valley walls. Most of these are intermittent. Rosgen describes the A3 and A4 as generally unstable with high sediment supplies. Most of these channels have not been field reviewed. Observations at the mouths of some streams (e.g. Glenn Canyon of Phillips Creek) along the main valley bottom indicates that periodic debris flows scour upper reaches and leave fan deposits at the mouth. On smaller channels, dry ravel appears to be the dominant source of sediment. The last major scouring event occurred during the 1996 runoff. Sheep trailing along Dry Creek tributaries in 2014 caused noticeable disturbance along channel bottoms and adjacent hillslopes, especially where fine-grained soils occur.

Floodplain Function (Executive Order 11988)

Executive Order11988 is applicable to those Federal actions which will occur in or which will impact upon floodprone areas. The Water Resources Council Floodplain Management Guidelines (WRC 1978) define action as any "Federal activity including 1) acquiring, managing, and disposing of Federal lands and facilities; (2) providing federally undertaken, financed or assisted construction and improvements; and (3) conducting Federal activities and programs affecting land use, including but not limited to water and related land use resources planning, regulating, and licensing activities."

All agencies are required to act, not merely consider, reducing risk, minimizing adverse impacts, and restoring and preserving floodplain values. The E.O. emphasizes that all actions, even those which do not result in a physical change, must be evaluated for their impacts to or within the floodplain. The flood hazard aspects, and to the degree they are quantifiable, the floodplain value aspects should be expressed in terms of potential for affecting the natural and beneficial floodplain values. The E.O. also provides direction to restore and preserve the natural and beneficial values served by floodplains.

Forest Service Manual 2527 defines the base floodplain as the lowland and relatively flat areas joining inland and coastal water including the debris cones and flood-prone areas of offshore islands and, at a minimum, that are subject to a 1 percent (100-year recurrence) or greater chance of flooding in any given year. The manual further defines the floodway as that portion of the floodplain which is effective in carrying flow, within which this carrying capacity must be preserved and where the flood hazard is generally highest; that is, where flood depths and velocities are the greatest.

Floodplains or floodways occur along all streams within the project area. Stream channel morphology, by default, includes the floodplain or floodprone area. Floodplain function is integral to the Rosgen classification system. The entrenchment ratio describes the vertical containment of a stream. Steep type

'A' streams have limited floodplain development due to topographic constraints. Type 'G' and 'F' streams generally represent disequilibrium and are incising within the valley floor and have diminished access to former floodplains or floodprone areas. Stable C type streams have wide and well-developed floodplains and B streams types, although topographically limited, also contain functional floodplains.

Measures used to assess effects to floodplains and riparian areas include road-stream crossings, roads within RHCAs (Table 22) and large wood. Road decommissioning in Thomas Creek, Phillips Creek and Dry Creek subwatersheds in the 1990s reduced mapped RHCA road density by about 14% which has helped to improve the RHCAs by allowing vegetation to regrow along some road corridors. Road miles and density includes decommissioned roads because most of these routes have not been totally obliterated from the landscape.

Table 22: RHCA Road Interactions at the subwatershed scale

SWS Name	RHCA (mi^2)	Road Miles w/in RHCAs	RHCA Road Density (mi/mi^2)	Road Miles Decommissioned	Stream- Road Intersections
Dry Creek	5.1	16.3	3.2	5.1	108
Phillips Creek	7.7	35.2	4.6	2.8	229
Thomas Creek	4.2	11.7	2.8	0.7	88
		63.2			425

The floodplain along lower Phillips Creek (5-6 miles or so) has been altered by past management practices. A floodplain is present and developing, but is narrower and less complex than historically, due to channel incision and lack of large wood. Thus, the stream's ability to dissipate energies associated with high flows is compromised and the stream is at risk of degradation from even moderately high flows (10-25 year events). Floodplains or flood prone areas along Dry Creek and Upper Phillips Creek are more confined, due to the narrow valley in which the streams occupy. Dry Creek has segments that occur as type 'G' streams, mostly where the stream is cutting through alluvial fan deposits at the mouths of tributaries, with a resultant loss of floodplain function. The floodplain of Spring Creek has apparently increased as a result of conversion from stream type 'A' to type 'B', while the floodplain of Thomas Creek (more than 2 miles downstream of the project area) has been reduced by conversion to an 'F' stream type. Spring Creek Tributary in Units 15B and 16B is reduced due to the incised nature of the channel as a result of headcutting, which has lowered the base level of the stream below the valley floor.

Riparian Soil Condition

Riparian areas include springs, streams, ponds, lakes and their associated wet areas and floodplains (FSM 2526). The three subwatersheds containing the project area contain about 10,900 acres of stream-associated RHCAs (Table 23), as mapped using standard PACFISH buffers (see Management Direction section for buffer distance). RHCAs within the Thomas Creek project area total about 4,000 acres. The project area also contains 28 known riparian areas associated with springs and seeps, or about 2 acres when applying PACFISH buffers.

Table 23: Thomas Creek Project Area RHCA summary (acres)

Subwatershed	Class I	Class III	Class IV	Total
Dry Creek (Project Area)	1,041 (320)	693 (244)	1,522 (840)	3,256 (1,405)
Phillips Creek (Project Area)	1,125* (583)	1,394 (476)	2,417 (1,001)	4,936 (2,060)
Thomas Creek	420	981	1,306	2,706

(Project Area)	(0)	(177)	(356)	(533)
*nonFS acres not well-mapped				10,898 (3,998)

Measures used to assess effects to riparian areas include road-stream crossings and roads within RHCAs. Road crossings of streams are often the places where eroded soil enters the water. Eroded soil is mobilized by rain and snow melt. Road decommissioning in Thomas Creek, Phillips Creek and Dry Creek subwatersheds in the 1990s reduced mapped RHCA road density by about 14% which has helped to improve the RHCAs by allowing vegetation to regrow along road corridors. Table 24 summarizes road-stream interactions at the project scale. Road miles and density includes decommissioned roads because most of these routes have not been totally obliterated from the landscape.

Table 24: RHCA Road Interactions within the Project Area

SWS Name	RHCA (mi^2)	Road Miles w/in RHCAs	Road Miles Decommissioned	Stream- Road Intersections
Dry Creek	2.2	11.1	5.1	77
Phillips Creek	3.2	14.6	2.2	135
Thomas Creek	0.8	5.8	0.2	52
	6.2	31.6	7.5	264

Riparian vegetation communities within the project area have been altered by recent and historic disturbances including road construction, timber harvest, and livestock trailing and grazing. Crowe and Clausnitzer (1997) describe riparian-wetland plant associations of the Umatilla National Forest and Table 25 summarizes communities most likely to occur within the project area. Large scale fire has not occurred in the project area in recorded history. Fire is actively suppressed and fire regime condition class is considered to be a slight to moderate departure from in Dry and Phillips Creek subwatersheds and moderately altered in the Thomas Creek subwatershed.

Table 25: Dominant Riparian Plant Associations in the Thomas Creek Project Area

Plant Association	Elevation	Location
Black Cottonwood/Pacific Willow	3350 - 4850	Lower Phillips Creek; lower East Phillips Creek
Black Cottonwood/Mountain Alder-Red osier Dogwood	3900 – 4600	Lower Phillips Creek to about a mile upstream of East Phillips Creek; lower East Phillips Creek
Grand Fir/Oak Fern	3500 - 4100	Upper Phillips Creek, East Phillips Creek, Dry Creek, Thomas Creek and Class III and IV tributaries
Grand Fir/Lady Fern	3900 – 5000	same
Grand Fir/Rocky Mountain Maple	3200 - 4400	same
Mountain Alder/Lady Fern	3450 - 4950	same
Sitka Alder/Lady Fern	3800 – 5400	same

The Pedro-Colt Fisheries Report (Crabtree 2001) summarized stream conditions in Dry, Phillips and East Phillips Creeks. Crabtree found that about 3 miles of previous harvest units along Phillips Creek are lacking in large wood and habitat complexity. In 1994, the 3.9 mile reach from the Forest boundary upstream to East Phillips Creek was about 30% dry and the reach from East Phillips Creek upstream 4.1 miles was about 60% dry. Recon also noted that all overstory shade had been removed in clearcut units (Units 99, 101, 102, 104, 106, 107) and that cottonwood and willow were regenerating well while conifer plantings were not. The report noted that pool forming structures installed in reaches 2 and 3 of Phillips Creek were put in without regard to flow regime and that structure in seasonally dry areas were probably doing more harm than good for fish populations.

Wetlands (Executive Order 11990) and Groundwater Dependent Ecosystems

Wetlands are those areas that are inundated by surface or ground water with a frequency sufficient to support and that, under normal circumstances, do or would support a prevalence of vegetation or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction (FSM 2527). The objective of E.O. 11990 is to avoid to the extent possible, the long and short term adverse impacts associated with the destruction or modification of wetlands and to enhance the natural and beneficial values of wetlands. The project area contains two types of wetlands: riverine and slope.

Riverine wetlands occur in floodplains and riparian corridors in association with stream channels. Dominant water sources are overbank flow or subsurface hydraulic connections between the stream channel and wetland areas. Riverine wetlands lose subsurface water by discharge to the channel, movement to deeper groundwater and evapotranspiration. As discussed above, the project area contains about 4,000 acres of stream-associated RHCAs, although actual wetlands would comprise a smaller portion of the RHCAs. The extent of stream-associated wetlands have not been mapped in the subwatersheds or project area.

Spring-associated wetlands within the three subwatersheds containing the project area have not been mapped in detail. The North End Allotment range improvements GIS layer identifies 34 stock tanks and 2 spring developments in these subwatersheds. One other mapped spring (Squaw Spring) occurs at the head of Phillips Creek. The project area contains 29 known slope wetlands and 23 earthen stock tanks (Attachment 3). Most of these wetlands occur as small (< 0.05 acres) seeps and springs. Slope wetlands are found in association with discharge of groundwater to the land surface or at sites with saturated overland flow and lose water primarily by saturated subsurface flow, surface flows or evapotranspiration. Slope wetlands may occur with no channel formation or they may develop channels that convey water downslope. Most of the springs identified during field reconnaissance in 2014 are located in valley bottoms of Class IV streams.

PACFISH buffers would encompass about 5 acres of spring or seep-associated RHCAs. The North End Allotment range improvements GIS layer identifies 19 earthen tanks and 2 spring developments within the project area. Thirteen of the 23 stock tanks were field verified. Of these 13 stock tanks, 5 are fed by runoff only and 8 have altered the natural surface and subsurface flow paths of the spring-associated wetlands by excavating and berming. Five spring-associated wetlands in the Dry Creek subwatershed are being adversely impacted by sheep and wildlife use.

Phillips Creek Fire (August 2015)

The Phillips Creek Fire perimeter contains approximately 2,600 acres in the Phillips Creek subwatershed (Attachment 4 and Table 26). The fire pattern resulted in a mosaic of unburned to moderate soil burn severity with almost no hydrophobic conditions detected. Within the fire perimeter, only about half of the area experienced fire and less than 20% burned with moderate to high severity. At the subwatershed scale, < 2% of the area burned with moderate and high fire severity. No proposed treatment units were affected by the fire but the fire perimeter included about 600 acres of the originally proposed 1,350 acre landscape burn area. Approximately 15 miles of dozer line were constructed during fire suppression and subsequently rehabbed as specified in the Phillips Creek Fire Suppression Repair Plan (USDA Forest Service 2015).

Table 26: Soil Burn Severity Acres in the Phillips Creek Subwatershed

	HUC6	Burn Boundary	Burn Severity			
			High	Moderate	Low	Unburned
All Ownership	24,762	2,600	9	444	775	1,372
NFS Lands	17,389	2,003	9	385	666	943
Thomas Creek Project	7,480	---	9	241	381	---

Table 27 shows that about 7.5 miles of Class I and IV stream channels experienced low to moderate severity fire.

Table 27: RHCA Soil Burn Severity Acres by Stream Class

Stream Class	Units	High	Moderate	Low
I (Phillips Creek)	Miles	0	0.3	0.3
	RHCA Acres	0	21	25
IV	Miles	0.1	3.4	3.3
	RHCA Acres	3	83	80

The hydrology report for the Phillips Creek Burned Area Emergency Response (BAER) summarizes burn severity and potential post-fire hydrologic implications (Napkora 2015). The modeled storm for the BAER was a 25 year/6 hour event producing 1.7 inches. The model predicted an order of magnitude increase in runoff from drainages that experienced moderate to high soil burn severity.

The potential for increased hillslope runoff (from high intensity rainfall, rain-on-snow or rapid snowmelt) and sedimentation from the moderate to high burn severity areas will be elevated for about 3-5 years. Post fire storm patrols are being implemented to maintain free-flowing culverts and roadside ditches. The High Ridge SNOTEL site (located about 7 miles northwest of the burn) recorded 1.4” rainfall on 9/05-06 and 1.5” rainfall event on 10/31-11/01. Neither of these storms generated noticeable runoff from the burned area (personal observation on 9/08/15 and personal communication with roads manager Steve Anderson for 10/31-11/01 event). The High Ridge SNOTEL site represents the upper end of the rainfall distribution and the burned area probably received less precipitation due to its lower elevation and southern aspect. Post-fire green-up, in addition to needle cast has helped to re-establish ground cover, thereby reducing the potential for detachment and transport of soil particles from moderate-high burn severity hillslopes.

Localized changes to channel morphology along 0.3 miles of Phillips Creek that burned with moderate severity may occur as a result of stream energies associated with bankfull and higher streamflows. Fire crews felled several snags into this stream segment and more are expected to fall during the next several years. The addition of this large woody material will help dissipate high stream flow energies and may help to detain sediment from washing downstream. Herbaceous and woody vegetation on floodplains is expected to regenerate rapidly and will aid in dissipating high streamflow energy and capturing sediment from overbank flows.

No treatment units proposed in the Thomas Creek Project area were affected by the fire. The fire burned about half of the landscape burn area and this area is expected to revegetate rapidly due to the mosaic burn pattern and the presence of herbaceous seed source. Fire managers assessed this area and concluded that burn objectives were met, therefore, this 600 acre portion of the 1,350 acre polygon is dropped from the original proposal.

Management Direction

Desired Condition

Desired conditions and standards and guidelines needed to achieve desired conditions are summarized below from PACFISH (USDI 1995) and the Umatilla National Forest Plan (USFS 1990). PACFISH amended the UNF Plan, however, only to the extent that it is more restrictive than Forest Plan criteria.

Applicable PACFISH Appendix C Excerpts

Riparian Goals Page C-4

The goals are to maintain or restore:

(1) water quality to a degree that provides for stable and productive riparian and aquatic ecosystems;
(2) stream channel integrity, channel processes, and the sediment regime including the elements of timing, volume, and character of sediment input and transport under which the riparian and aquatic ecosystems developed;
(3) instream flows to support healthy riparian and aquatic habitats, the stability and effective function of stream channels, and the ability to route flood discharges;
(4) natural timing and variability of the water table elevation in meadows and wetlands
(5) diversity and. productivity of native and desired non-native plant communities in riparian zones;
(6) riparian vegetation to:
   a) provide an amount and distribution of large woody debris characteristic of natural aquatic and riparian ecosystems;
   b) provide adequate summer and winter thermal regulation within the riparian and aquatic zones; and
   c) help achieve rates of surface erosion, bank erosion, and channel migration characteristic of those under which the communities developed.
(7) riparian and aquatic habitats necessary to foster the unique genetic fish stocks that evolved within the specific geo-climatic region; and
(8) habitat to support populations of well-distributed native and desired non-native plant, vertebrate, and invertebrate populations that contribute to the viability of riparian-dependent communities.

Definitions

	Fish bearing	**Permanently flowing Non-fish bearing**	**Ponds, lakes, reservoirs and wetlands >1 Ac**	**Seasonally flowing or intermittent streams, wetlands < 1 ac, landslides and landslide-prone areas**
PACFISH Category	Category 1	Category 2	Category 3	Category 4
R-6 Stream Class/Legacy stream maps	Class I, II	Class III	NA	Class IV (intermittent streams)
PACFISH Widths	2 SP tree*	1 SP tree	1 SP tree	1 SP tree
PACFISH "Default"	or 300 ft.	or 150 ft.	or 150 ft.	or 100 ft.

*SP = Site Potential

Riparian Management Objectives (RMOs) page C-4

All of the described features may not occur in a specific segment of stream within a watershed, but all generally should occur at the watershed scale for stream systems of moderate to large size (3rd to 7th order).

RHCAs include traditional riparian corridors, wetlands, intermittent streams, and other areas that help maintain the integrity of aquatic ecosystems by (1) influencing the delivery of coarse sediment, organic matter and woody debris to streams, (2) providing root strength for channel stability, (3) shading the stream, and (4) protecting water quality.

Table 28: Interim RMOs apply to streams in watersheds with anadromous fish

Habitat Feature	Interim Objectives
Pool Frequency (kf) (all systems)	Varies by channel width, see below:
wetted width in feet:	10 20 25 50 75 100 125 150 200
number pools per mile:	96 56 47 26 23 18 14 12 9
Water Temperature (sf)	No measurable increase in maximum water temperature. * Maximum water temperatures below 64°F within migration and rearing habitats and below 60°F within spawning habitats
Large Woody Debris (sf) (forested systems)	Costal Californian, Oregon, and Washington. >80 pieces per mile; >24 inch diameter; >50 foot length
	East of Cascade Crest in Oregon, Washington, Idaho. >20 pieces per mile; >12 inch diameter; >35foot length

Bank Stability (sf) (non-forested systems)	>80 percent stable
Lower Bank Angle (sf) (non-forested systems)	>75 percent of banks with <90 degree angle (i.e., undercut).
Width/Depth Ratio (sf) (all systems)	<10, mean wetted width divided by mean depth
kf = key feature	sf = supporting feature

RMO Modifications:

1) RMO modifications require completion of watershed analysis to provide the ecological basis for the change.
2) RMOs may be modified in the absence of watershed analysis where watershed or stream reach data support the change.
3) In all cases, RMO modifications, the rationale supporting those changes and the effects of the changes will be documented.
4) Within the range of listed salmon, modification of RMOs will be done in consultation with NMFS.

STANDARDS AND GUIDELINES

General Riparian Area Management, page C-17

RA-2 Trees may be felled in RHCAs when they pose a safety risk. Keep felled trees on site when needed to meet woody debris objectives.

RA-3 Apply herbicides, pesticides and other toxicants and other chemicals in a manner that does not retard or prevent attainment of RMOs and avoids adverse effects to listed anadromous fish.

RA-4 Prohibit storage of fuels and other toxicants within RHCAs. Prohibit refueling within RHCAs.

RA-5 Locate water drafting sites to avoid adverse effects to listed anadramous fish and instream flows and in a manner that does not retard or prevent attainment of RMOs.

Timber Management, page C-10

TM – 1 Prohibit timber harvest, including fuelwood cutting, in Riparian Habitat Conservation Areas, except as described below. Do not include Riparian Habitat Conservation Areas in the land base used to determine the Allowable Sale Quantity, but any volume harvested can contribute to the timber sale program.

b. Apply silvicultural practices for Riparian Habitat Conservation Areas to acquire desired vegetation characteristics where needed to attain Riparian Management Objectives. Apply silvicultural practices in a manner that does not retard attainment of Riparian Management Objectives and that avoids adverse effects on listed anadromous fish.

Roads Management page, C-10-12

RF – 2 For each existing or planned road, meet the RMOs and avoid adverse effects on listed anadromous fish by:

d. avoiding sediment delivery to streams from the road surface
e. avoiding disruption of natural hydrologic flow paths
f. avoiding sidecasting of soils or snow. Sidecasting of road material is prohibited on road segments within or abutting RHCAs in watersheds containing designated critical habitat for listed anadromous fish.

RF-3 Determine the influence of each road on the RMOs. Meet RMOs and avoid adverse effects on listed anadromous fish by:

a. reconstructing road and drainage features that do not meet design criteria or operation and maintenance standards, or that have been shown to be less effective than designed for controlling sediment delivery, or that retard attainment of RMOs, or do not protect designated critical habitat for listed anadromous fish from increased sedimentation.

b. Prioritizing reconstruction based on the current and potential damage to listed anadromous fish and their designated critical habitat, the ecological value of the riparian resources affected and the feasibility of options such as helicopter logging and road relocation out of RHCAs
c. Closing and stabilizing or obliterating roads not needed for future management activities. Prioritized these actions based on the current and potential damage to listed anadromous fish and their designated critical habitat and the ecological value of the riparian resources affected.

RF-5. Provide and maintain fish passage at all road crossings of existing and potential fish-bearing streams

Fire/Fuels Management, page C-15-16

FM-1 Design fuel treatment and fire suppression strategies, practices, and actions so as not to prevent attainment of Riparian Management Objectives, and to minimize disturbance of riparian ground cover and vegetation. Strategies should recognize the role of fire in ecosystem function and identify those instances where fire suppression or fuel management actions could perpetuate or be damaging to long-term ecosystem function, listed anadromous fish, or designated critical habitat.

FM-4 Design prescribed burn projects and prescriptions to contribute to the attainment of the Riparian Management Objectives.

GLOSSARY

Attain RMOs – Meet riparian management objectives for the given attributes. For habitats below the objective level, recovery will be initiated during the period the interim strategy is in place. For habitats at or better than the objective level, maintain at least the current condition. Actions that 'degrade' habitat conditions (as defined elsewhere) would be considered inconsistent with the concept of attaining RMOs.

Degrade – Measurably change an RMO feature in a way that:
- Further reduces habitat quality where existing conditions meet or are worse than objective values
- Reduces habitat quality where existing conditions are better than the objective values

Prevent Attainment of RMOs – Preclude attainment of habitat conditions that meet RMOs. Permanent or long-term modification of the physical/biological processes or conditions that determine the RMO features would be considered to prevent attainment of RMOs.

Retard Attainment of RMOs – Measurably slow recovery of any identified RMO feature (e.g. pool frequency, water temperature, etc.) that is worse than the objective level. Degradation of the physical/biological process or conditions that determine RMO features would also be considered to retard attainment of RMOs.

UMATILLA NATIONAL FOREST LRMP Standards and Guidelines

(Where direction contained in existing plans is more restrictive than PACFISH direction the plan direction applies - PACFISH Q&As, May 24, 1995)

Table 29. Riparian/Fish Habitat – Forest-wide Standards and Guidelines

Wetlands and Floodplains	• Meet the direction and processes for management of wetlands and floodplains in accordance with E.O. 11990 and E.O. 11998 and FSM 2527.
Best Management Practices	• Implement BMPs to meet water quality standards and protect streams and adjacent areas to maintain aquatic resources.
Class IV Streams	• Management activities will not deteriorate water quality below existing established water quality goals for downstream Class I and II streams; water quality changes in Class IV streams may involve some temperature and sediment increases • Woody vegetation and ground cover adjacent to stream channels will be managed to provide a continuous supply of in-channel large woody material to the stream in order to maintain or enhance streambank stability and to filter sediment generated on adjacent slopes. • Felling, skidding and road construction across the stream should be avoided. When streams cannot be reasonably avoided, activities should be conducted at times when streams are dry and at locations where streambank and stream channel disturbances are minimized. Skid trail crossings of intermittent stream channels will be predesignated. • Roads and trails shall be located, constructed and maintained so that the streambank and stream

<table>
<tr><td></td><td>channel receive as little disturbance as possible.
• Human-caused woody debris, < 6” in diameter and > 4’ in length, that gets into the stream channel shall be carefully removed unless otherwise justified by environmental analysis.
• Within riparian areas, ground-disturbing activities will be limited to the degree necessary to maintain and protect water quality and fish habitat.
• Assess the potential for improving stream and riparian conditions, and where opportunities exist, improve intermittent streams to perennial flows.
• Manage roads and trails to protect riparian wildlife values, fish habitat and water quality. Water quality and/or fish habitat problems caused by roads will be corrected.</td></tr>
<tr><td>Class III Streams</td><td>• Avoid felling timber across stream channels.
• All logs shall be fully suspended over the stream or crossed on temporary structures.
• Within the riparian areas, limit mineral soil exposure by ground-disturbing activities to 10% of the project area.
• For Class I, II and III stream reaches which exceed desired maximum stream temperatures (State water quality standards), management activities within the surrounding contributing watershed shall not reduce stream surface shade below ecological potential (EP). Where EP has not been determined for a reach, assumed EP shall be 80% stream surface shade.
• For Class I, II and III stream reaches which do not exceed desired maximum stream temperatures management activities within the surrounding contributing watershed shall not reduce stream surface shading more than 20% below EP in upstream reaches. Where EP has not been determined for a reach, assumed EP shall be 80% stream surface shade.
• Trees within one tree height of the stream channel will be managed to provide for a continuous supply of naturally occurring large woody material for future instream fish and riparian habitat in adjacent and downstream reaches.</td></tr>
<tr><td>Class I and II Streams</td><td>Management practices will not degrade water quality, fish, or aquatic resources below the water quality goals, except for temporary change due to permitted activities. The following practices are in addition to guidelines for Class III and IV streams:
• Streambanks should have 80% or more of their total lineal distance in a stable condition.
• Any increases in water temperature will be consistent with State standards.</td></tr>
<tr><td>Water</td><td>• Meet or exceed state water quality standards
• For all lands within national forest boundaries (including private inholdings), no more than 30% of the forest land within a subwatershed will have timber stand age classes of 0-10 years except where analysis documented in an environmental assessment indicates that watershed condition would not be impaired.
• Select, design, implement, enforce, monitor and adjust BMPs.</td></tr>
<tr><td>Soil</td><td>• Plan and conduct land management activities so that reductions of soil productivity potential causes by detrimental compaction, displacement, puddling and severe burning are minimized.
• Maintain a minimum of 80% of an activity area in a condition of acceptable productivity potential.
• Maintain minimum percent effective ground cover after cessation of any soil-disturbing activity as follows:
<table>
<tr><th rowspan="2">Erosion Hazard Class</th><th colspan="2">Minimum % Effective Ground Cover</th></tr>
<tr><th>1st Year</th><th>2nd Year</th></tr>
<tr><td>Low (very slight)</td><td>20-30</td><td>30-40</td></tr>
<tr><td>Medium (moderate)</td><td>30-45</td><td>40-60</td></tr>
<tr><td>High (severe)</td><td>45-60</td><td>60-75</td></tr>
<tr><td>Very High (very severe)</td><td>60-75</td><td>75-90</td></tr>
</table>
• Active slump and landslide areas will generally be considered to be unavailable for road construction.
• Along all perennial streams, adjacent floodplains and riparian areas take actions to prevent soil movement, including slumps, earth slides and other debris and material from moving downstream into higher class streams.
• In floodplains, riparian areas and aquatic habitats, ground-disturbing activities are limited to the degree necessary to minimize erosion and sedimentation.</td></tr>
</table>

Table 30. C5 – Riparian – Standards and Guidelines

Fish	• Riparian vegetation will be managed to promote floodplain, bank and channel stability, to provide resiliency to disturbance and promote aquatic diversity. • Where natural conditions permit, streamside vegetation along the entire length of perennial streams will be managed to maintain an average shading of 80% of the entire stream surface shaded. Where existing shading is already below this level, retain all vegetation contributing to stream surface shading. • Lands and trees adjacent to perennial streams will be managed to provide for a continuous, well distributed supply of naturally occurring, large woody material for in-stream fish and riparian habitat. At a minimum, these lands will include a zone within one tree height of the stream channel. • Streams will be managed to provide pools that are relatively large, frequent, well distributed and persistent during low flows. • Forest-wide standards for temperature and in-stream flows will be met. • The sediment budget will fall well within the range and frequency adapted to by indigenous aquatic communities.
Timber	• Created openings adjacent to live streams may be permitted, provided the stream surface shading, large woody material and water quality requirements for fisheries are met. If natural shading is below the 80% level, meet the Forest-wide standards and guidelines for riparian/fish habitat (Class III streams). • Created openings should generally be 1 acres or smaller, but no larger than 2 acres in size. No more than 6% of the entire riparian area within a subwatershed will be created openings (trees < 10 feet in height) at any time.
Soil	• Within 250 feet of all streams and wet areas associated with streams, limit the mineral soil exposed by ground-disturbing activities to 10% of the project area.
Transportation	• Construction, reconstruction and the maintenance of roads will be permitted when consistent with the riparian management goals. New roads should be located outside the riparian area (except for crossings) unless alternatives are determined to have higher adverse impacts to resources. • Water quality and fisheries habitat problems caused by roads will be corrected.
Fuels/Rx Fire	• Fuels management activities will be designed and executed to maintain or enhance the anadramous fish and wildlife habitat within the constraints of 10% exposed mineral soils and 80% stream surface shading. • Fuels should not exceed an average of 9 tons per acre in the 0-3 inch size class and an average residue depth of 6 inches, as depicted in the Photo Series for Quantifying Forest Residues (Technique Report PNW 52): 3-PP4-PC, 4-PP-1-TH, 1-PP&ASSOC-4-PC, 2-LP-3-PC • Prescribed fire may be used consistent with riparian objectives

Table 31. Transportation System – Standards and Guidelines

Road Closures	• Obliterate all roads not in the Forest Development System or authorized by permit, lease or easement. Obliterated roads will be revegetated to provide stabilization and to return the area to its intended use. • Short term (temporary) roads will be obliterated.

Environmental Consequences

The alternatives are described in the *Thomas Creek Restoration Project Alternatives Description*. Environment consequences will be analyzed for 5 alternatives for the Thomas Creek Project. Tables 32and 33 summarize treatment characteristics and modeling results used to evaluate effects of silvicultural treatments to water quality, water yield, RHCA and wetland condition.

Table 32. **Treatment characteristics used to evaluate soil and watershed effects**

Action Alternative:	B	C	D	E
Treatment Acres	**2,546**	**2,598**	**2,417**	**3,068**
Tractor Yarding	765	814	494	928
Forwarder Yarding	374	430	398	572
Skyline Yarding	164	84	57	292
Hand Thinning	1,276	1,270	1,468	1,276
RHCA Class I – noncommercial	172	172	134	172
RHCA Class III – noncommercial	101	100	102	101
RHCA Class III – commercial	28	5	0	28
RHCA Class IV – noncommercial	234	233	370	234
RHCA Class IV – commercial	155	145	0	155
Fuel Treatments Acres				
Lop and Scatter (NCT)	1,276	1,270	1,468	1,276
Hand Pile (A4 treatment area)	38	38	38	60
Landing Pile (whole tree yard)	923	925	578	1,221
Grapple Pile	347	403	371	572
Pile Burn, hand and grapple piles (5% or area)	20 (385)	22 (441)	21 (371)	32 (632)
Pile Burn, landing piles (5% of area)	46 (923)	46 (925)	29 (578)	61 (1221)
Jackpot Burn (~ 50% of surface blackened)	305	305	285	305
Broadcast Burn (~ 80% of surface blackened)	122	109	107	122
Landscape Burn	984	984	984	984
Roads				
Haul Routes, mi	45.8	44.6	39.6	54.3
Haul Routes in RHCAs, mi	15.0	14.9	13.9	15.8
Stream Crossings on Haul Routes	97	96	87	107
ML 1 roads temporarily opened, mi	13.6	12.7	10.0	18.5
New Temporary road construction, mi	1.0	0.75	0	1.0
ML1 and Temporary roads in RHCAs, mi	1.8	1.6	1.1	2.3
Re-Installed Temporary drainage crossings	1	1	0	1

Table 33. **Modelling results used to evaluate sediment and water yield**

Alternative:	A	B	C	D	E
Sediment Modeling (WEPP Road)					
Haul Road Sediment, tons	---	4.9	4.9	3.6	5.6
Hillslope Sediment (Soils Report)					
Detrimental Soil Condition, acres	10	4	4	3	4
ETA (HUC6)*					
Dry Creek (170601040801)	2.3%	7.0%	7.1%	6.9%	8.0%
Phillips Creek (170601041101)	2.8%	7.4%	7.4%	7.1%	7.9%
Thomas Creek (170701030101)	1.5%	7.9%	8.4%	7.3%	9.2%

*NOTE: the ETA model results do not include the following changes from the original alternatives: 1) change 25 acres from clearcut to shelterwood, 2) 453 acres of moderate/high severity fire, 3) reduction of 750 acres of

Alternative:	A	B	C	D	E
Rx fire (1,582 to 984). All model results are well below the threshold value of 15%. Updating the model with these small changes would not alter the comparison between alternatives, nor would there be a substantial change to the percent ETA from any alternative.					

Alternative A – No Action

Direct and Indirect Effects

Because the project would not occur, there would be no direct or indirect effects to the existing condition as described in the Affected Environment section. The processes described would continue on the current trajectory unless a large-scale disturbance such as a high severity fire or high intensity rainfall or rain-on-snow event occurs within the project area.

The direct effect of the Phillips Creek Fire was to kill the majority of overstory vegetation on areas where the fire burned with moderate to high soil burn severity, including 0.3 miles and 21 acres of RHCA along Phillips Creek (see Tables 32 and 33). The near-term loss of shade along Phillips Creek would not affect stream water temperature during the critical low flow season because this stream segment is dry during that time period. The loss of bank stabilizing vegetation along the burned portion of Phillips Creek has increased the risk of lateral scour during high stream flows. There is also an increased risk of sedimentation from hillslopes immediately adjacent to stream channels that burned with moderate to high severity. Herbaceous and deciduous woody vegetation is expected to recover rapidly, although the erosion/sedimentation risk would remain elevated for up to three years after the fire.

Actions Common to All Alternatives – Large Wood and Riparian Hardwood

The Thomas Creek Project proposes to add large woody material to Phillips Creek to improve channel morphology and in-stream processes. Trees felled would aid in floodplain development, stream bank stability, habitat improvement, sediment storage and nutrient cycling. Addition of large woody material would also improve floodplain function by adding large roughness elements that help dissipate high flow energies. Large woody material would be brought in from off-site or may also be strategically felled streams during thinning. Forest Service aquatic specialists would work closely with the layout crew to identify trees and falling strategies.

Prior harvest and channel clean-out have reduced the amount of in-channel large wood and eliminated a rotation of potential wood recruitment. The Pedro-Colt EA (2001) considered a project to place 100 to 200 trees with rootwads into 3 miles of Phillips Creek, with a target of 40 pieces per mile. The overall objective was to increase habitat complexity and hiding cover for fish. The hydrology and fisheries reports analyzed this project, but the proposal was not carried forward into the decision. Fox and Bolton (2007) recommend about 34 ‘key’ pieces of large wood per mile for the Douglas-fir/Ponderosa pine zone of Washington, and over 10 times that amount of other woody debris. They did not define a size class for key pieces, instead the size would be dictated by bankfull width and (presumably) use the WFPB definition of key piece as independently stable in the bankfull channel width and capable of entraining other organic debris.

OWEB (1999) provides guidance for wood placement for non-federal lands. For a stream reach to be considered depleted, the reach should have less than 45 pieces of large wood (6 inches or greater in diameter and 10 feet or greater in length) and/or less than 6 key pieces (at least 24 inches in diameter and length greater than the average bankfull channel width of the stream reach) per 1000 feet of stream. OWEB defines the length of LWD as at least 2 times the bankfull width without rootwad or 1.5 times bankfull width with rootwad attached. Additionally, OWEB defers to ODF/ODFW (2010) wood placement guidance. ODF/ODFW specifies minimum diameter of key pieces based on bankfull width:

Bankfull Width (ft)	Minimum Diameter (in)
0 – 10	10
10 – 20	16
20 – 30	18
> 30	22

The Thomas Creek Project does not include detailed design specifications for the locations, amounts, arrangement, or construction of large woody material. All specifications and design features associated with wood size, configuration and placement would conform to OWEB, ODF/ODFW and NMFS ARBO II (2013) standards. Installation of a typical in-stream habitat structure will include excavation of a trench in the floodplain and/or streambank, installation of log/rootwad, installation of anchor rock (if needed) and backfilling with native fill and bucket compaction of the bank/bed. Each structure would have a unique installation procedure depending on the complexity of the structure and the interaction with other logs, rootwads and rocks. To the extent practicable, existing vegetation will be maintained on the floodplain. Plant stock for native trees, shrubs and grasses would be from local seed sources that are adapted to growing conditions at the project site.

The Thomas Creek Project also proposes to increase riparian shade by releasing and/or planting understory alder and willow and improving the vigor and density of overstory cottonwood communities. Thinning would occur within the limitations of Forest Plan S&Gs and of the design features.

Project Design Features and Mitigation Measures

The project design would include BMPs and project design features applicable to all action alternatives and these are listed in Attachment 5.

Direct and Indirect Effects

Phillips Creek Fire Effects - All Action Alternatives

There would be no direct or indirect effects of the fire on the proposed treatments because no treatment units were burned by the fire. The fire burned about half of the originally proposed 1,372 acre landscape burn area and this area is expected to revegetate rapidly due to the mosaic burn pattern and the presence of herbaceous seed source. Fire managers have reviewed the burned hillslope and the burned portion is dropped from all alternatives.

Temperature – The fire killed many of the conifer and cottonwood trees along a ¼ - ½ mile segment of Phillips Creek, thereby affecting overstory shade. This segment of stream channel was dry during the fire in August 2015. A stream habitat survey was conducted along 8.5 miles of Phillips Creek on June 25 and 29, 2015. Reach 01 extended from the Forest boundary upstream 4.2 miles to the confluence of East Phillips Creek. Reach 02 extended from East Phillips Creek upstream another 4.5 miles. The stream segment that burned was already dry on June 25 and therefore the immediate reduction of shade along this reach would not affect stream water temperatures, therefore there would be no direct or indirect effects to stream water temperature.

Sediment – Sediment recruited from the streambank along the burned channel segment will have an elevated risk of erosion from bankfull and higher flow events until ground cover becomes re-established in the first growing season after the fire. Greenup has occurred post fire and herbaceous cover will resprout in the spring. Cottonwoods are the predominant riparian woody species along this stream segment and regeneration from top-killed trees and seed is expected to occur rapidly. Recruitment of streambank sediment would be a direct effect of the fire.

Fall rains initiated the first flush of sediment from burned hillslopes. Additional sediment may be mobilized from hillslopes with spring snowmelt. Due to the small acreage burned, high turbidities associated with peak runoff in Phillips Creek would most likely mask the additional hillslope sediment. These effects would be independent of the actions proposed in the alternatives.

Alternative B – Proposed Action

Refer to *Alternatives Considered in Detail* in the project record for a detailed description of the alternatives. The Vegetation Report describes the effects of this alternative to forest structure at the landscape scale. Within that landscape, this alternative would improve species composition, structural stage and density by about 12% toward the historic range of variability. As more of the landscape approaches HRV, the expected outcomes are improved forest health, vegetation vigor and ecosystem resilience to fire, insects and disease. The Fuels Report describes treatments for activity fuels and landscape fire. The landscape burning would largely be classified as low intensity surface fire (underburning) in which surface fuel reduction and mortality of understory and overstory components are commensurate with effects that could be expected to occur historically.

Summary: The direct effects of implementing the proposed action would be the removal of 5.84 MBF of timber from 1,270 acres (including development of skid trails, landings and 1 mile of temporary road) and precommercially thinning an additional 1,276 acres. Jackpot and pile burning would occur on about 20% of the area, or about 500 acres. Lop and scatter could occur on about 1,276 acres and prescribed fire is planned for an additional 984 acres.

The Umatilla Subbasin TMDL and WQMP identified sediment, temperature, and habitat modification as the primary concerns in meeting water quality standards on forested lands. Strategies to improve water temperature conditions include providing shade, and providing conditions for the development of natural channel morphologies, which are generally narrower and less easily heated than management affected channels. Current policies, regulations, BMPs, and adaptive management techniques are expected to minimize unwanted sedimentation from forestry related activities. Habitat conditions are expected to be improved through implementation of design features developed for the temperature TMDL which promote riparian conditions that improve vegetative condition toward HRV, enhance riparian hardwoods needed for shade and improve channel stability and promote the recovery of channel morphology to the most stable forms. The TMDL sediment model indicated that there was no need for significant reductions in fine sediment from forest lands and re-affirmed the Umatilla National Forest Plan's commitment to implementing BMPs to reduce sediment from management activities.

Sediment modeling indicates that the existing road system would continue to be the main source of sustained sediment input to streams. Road maintenance, reconstruction and temporary road construction would loosen surface soils, which would increase the short term risk of sediments being mobilized during rainfall. Design features related to timing of activities and installation of physical erosion measures would minimize the risk of erosion in the short term. Road maintenance and reconstruction, followed by closing/stabilizing Level 1 roads and obliteration of new temporary roads would reduce road-related sediment during the longer term.

On a watershed scale, this project would not measurably enhance nor retard attainment of RMOs. At the habitat and reach scale, the placement of large wood into Phillips Creek would enhance RMOs for large wood, pool frequency and width/depth ratio. At the reach scale, thinning may occur in up to 2% of non-contiguous acres of Class I and III RHCA s in the Dry Creek subwatershed, 9% in the Phillips Creek subwatershed and 3% in the Thomas Creek subwatershed. As a result of thinning, riparian hardwood and conifer release are expected to occur during the short term (1-5 years), while hardwood and conifer plantings are expected to take longer to become established and begin to provide effective shade (5 to 10 years). The net result would be an overall increase in near-stream shade, although the potential to influence stream temperature at the reach scale is low because of the location and extent of treatments.

Temperature and Shade

Measure: water temperature; RHCA canopy density

Attachment 6 lists proposed units which may include commercial and noncommercial thinning within Class I and III RHCAs. Alternative B would not adversely affect water temperature because thinning, burning, and placing large wood into streams would not measurably remove the shade component along any stream channel. Because there would be no change to shade, there would be no adverse effect to beneficial uses and no effect on the 303(d) listing status of streams listed for exceeding State temperature standards. Under Alternative B, only 301 acres of thinning activities would occur within Class I and III RHCAs and it would all be outside the shade producing area (Table 34). This action is consistent with the Upper Grande Ronde and Umatilla Subbasin Temperature TMDL target strategy of no increases in radiant energy above site potentials.

Table 34. Thomas Creek Project Area Class I and III RHCA acres

Subwatershed	Class I	Class III	Total
Dry Creek	1,041	693	1,734
Project Area	320	244	564
Alternative B	21	7	28
Phillips Creek	1,125*	1,394	2,519
Project Area	583	476	1,059
Alternative B	151	79	230
Thomas Creek	420	981	1,401
Project Area	0	177	177
Alternative B	0	43	43
*nonFS acres not well-mapped		**All**	**5,654**
		Project	**1,800**
		Alt B	**301**

In addition, no adverse changes to channel condition from silvicultural treatments are predicted because water yield and peak flow will not be affected, therefore, morphological channel changes which could affect stream temperature would not occur. Where large wood is placed into streams, the expected effect is to create channel conditions that would favor cooler water. These effects include increasing cover, reducing width/depth ratios and increasing exchange between shallow groundwater below the streambed with surface water.

Danger trees would be felled along all haul routes used in the proposed timber sales. They would be left on the ground inside RHCAs and commercially removed elsewhere. Most stream crossings on haul routes are ephemeral or intermittent (86 of 97) with no or very low summer flows. Danger trees felled on haul routes within RHCAs of perennial streams would have negligible effect on shade density for affected streams.

During harvest fuel treatment, underburning will occur in stands with residual fire resistant tree species. There will be no ignition within perennial RHCAs, however fire will be allowed to back into RHCAs. Prescribed fire may take place near perennial water in some locations. This low intensity fire will rarely kill shade-producing vegetation and there is a very low risk that the density of shade on water would be affected to the degree necessary to affect water temperature. Other harvest fuel treatments would rely on hand or machine piling outside of the primary shade zone. During landscape burning, no created openings of any size are expected inside Class I and III RHCAs. Shade and therefore effects to water temperature from landscape burning at near natural rates will be protected.

Hardwood and conifer planting may occur in the RHCAs. Hardwood and conifer release are expected to occur during the short term (1-5 years), while hardwood and conifer plantings are expected to take longer to become established and begin to provide effective shade (5 to 10 years). The net result would be an increase in near-stream shade.

Treatments within the Riparian Habitat Conservation Areas of intermittent streams and seep/spring wetlands would not affect stream temperature because shade is not the limiting water quality factor on these systems. Intermittent streams in the project area do not contribute to high temperatures because they are dry during the hottest period of the year. In addition, temperature in the seep/spring associated wetlands within the project area is a result of groundwater storage and not shade. At least nine seeps/springs have been developed into earthen stock tanks which has increased the solar exposure of these waters.

Maintenance level 1 and temporary haul routes would occur in 0.15 miles of Class I and III RHCAs. FR3200140 crosses Dry Creek and runs perpendicular through the RHCA for about 425 feet to access units 22, 112, 113 and 130. Vandals have removed the gate wood cutters, hunters and recreationists have been accessing this area. The road does not need to be brushed out and therefore, there would be no effect to shade from temporarily opening this road.

Water temperature can be increased by reductions in the density of shade over the water surface. Logging activities can initiate pronounced temperature changes by the removal of forest vegetation along channels (Beschta et al 1987). Prescribed burning and hazard tree falling in riparian areas has the potential to reduce existing vegetation. Re-opening non-forest service system roads in riparian areas has the potential to delay the passive recovery of vegetation on roads that are brushed out.

Increases in summer stream temperature due to removal of riparian vegetation are well documented and have led to development of best management practices to protect shade. The sun's angle (zenith) and position through the day (azimuth) together with other characteristics such as height, location and density of vegetation, width and orientation of the stream, and steepness of adjacent uplands, all influence shade and its effectiveness in protecting and maintaining water temperatures. Peak air and stream temperatures occur in July and August.

Many variables are involved in determining water temperature and the effect shade removal can have on water temperature. Different site conditions can lead to different effects, which are seen in the literature. In a regional study of Washington, Oregon and Idaho streams, Mayer (2012) found, on average, 68% of the variance in August weekly stream temperature at a site is related to air temperature and streamflow. He indicated that summer thermal sensitivities may be governed by local factors, such as riparian conditions and reach-specific channel geometry, rather than the regional controls.

The High Ridge Evaluation Area of the Umatilla Barometer Watershed had timber harvest in 1976 and 1984. Fowler et al (1979) reported maximum stream temperature did not exceed 60 ^{o}F during the 10 year period of record before logging began. After the first harvest, average maximum air temperature increased up to 4 ^{o}F, while average minimums decreased about 4.5 ^{o}F. Maximum and minimum water temperatures, however, decreased about 4 ^{o}F, possibly due to increased nocturnal cooling, increased snowpack and delayed melt due to north and northeast aspect. After the second harvest, maximum water temperatures increased 7^{o}, < 1^{o} and 13 ^{o}F in watersheds 1, 2 and 4 when compared to the control (which also had water temperatures higher than during the pre-harvest period). Helvey and Fowler (1995) concluded that since flow rates in late summer are barely measurable (flows were often < 0.005 cfs), these feeder streams have little or no influence on the temperature of the receiving stream. Moore et al (2005) also reported that temperature increases in headwater streams are unlikely to produce substantial changes in the temperatures of larger streams due to minimal flow.

On several local streams, Carlson et al (1990) has shown that angular canopy density was not significantly different in logged and unlogged stands 10 – 18 years after logging. They found that ACD reduction from overstory thinning was replaced by understory growth. They also found that a large wildfire that consumed 1/3 of a drainage basin and removed much of the riparian vegetation resulted in no immediate change to stream water temperature from the loss of shade.

Moore et al (2005) discussed water temperature effects as a result of harvest near streams and found that they are primarily controlled by changes in the amount of insolation but also depend on stream hydrology and channel morphology. Increased water temperatures were observed both with unthinned and with partial retention buffers. They also noted that temperature increases in headwater streams are unlikely to produce substantial changes in the temperatures of larger streams into which they flow, unless the total inflow of clear-cut heated tributaries constitutes a significant proportion of the total flow in the receiving stream. They also noted that one tree height on each side of a stream should be effective in reducing harvesting impacts on riparian microclimate and stream temperature.

Ebersole et al (2003a) observed that maximum temperatures were higher in reaches with lower frequencies of large wood and fewer pools due to channel simplification, straightening and widening. However, they found that reach riparian canopy density and maximum summer stream temperatures were not correlated among their 37 sites, likely because of the multiple factors influencing stream temperatures across a wide array of elevations and stream channel morphologies. In a companion study, Ebersole et al (2003b) found that riparian canopy cover manipulations strongly influenced temperatures of cold water refuges among 37 study sites within alluvial valleys of the Grande Ronde basin.

A 1991 study (Caldwell et al) of water temperature effects of riparian harvest that left no buffers on small perennial headwater streams, which were tributary to larger fish bearing streams, found very minimal influence on downstream water temperature. This was attributed primarily to the small relative volume of flow compared to downstream and the limited ability to store and transmit heat of these small headwater tributaries. Localized ground water influence was also identified as a contributor to stable stream temperatures. The study found that water temperature in small streams was responsive to localized conditions and quickly came into equilibrium with downstream conditions. Higher than expected shade levels were found in logged reaches, such as contributions from logging debris and understory brush in these western Washington streams.

The water temperature effect of headwater riparian harvest was evaluated in a northern Idaho study (Gravelle et al. 2007). Two treatment types were evaluated; clearcut and partial cut (thinning) on 50% of the drainage. One clearcut site showed an increase in peak water temperature in the stream reach of the clearcut, the downstream effect was slight. Temperature effects in the partial cut watershed ranged from very slight to no change. Long term monitoring sites, which were located at the base of each treated catchment to assess cumulative downstream temperature effects, indicated a slight cooling trend and no post treatment increase in peak stream temperature. Natural variation or increased water yield post-harvest could account for this result. The study did not detect change in the extent or timing of summer maximum water temperatures. Annual variation in precipitation, snow pack, and summer air temperatures, as well as ground water influence, and increased base flow contributed to these results.

The proposed action would harvest or thin trees from 172 acres of Class I and 129 acres of Class III RHCAs in 32 units (Attachment 6), within the standards and guidelines of the Forest Plan and within limitations specified in the design features. No material, standing trees or downed wood would be removed from within the inner gorge (the area including the stream and its floodplain and defined by a break in slope to uplands) of these channels.

Most of the streams in the project area trend northwest to southeast (or vice versa) or north to south (or vice versa). For streams flowing N-S, S-N, NE-SW or SW-NE, overstory shade is most important at high sun angles (generally from 10:00 – 14:00). This project would not change the angular canopy density and therefore shading would be maintained along all perennial streams. Because shade would not be changed, water temperature changes due to increased solar loading would not occur from this project.

The Spring Creek stream survey conducted in 2013 identified the stream draining from Units 15B and 16B as Tributary 4. Tributary 4 flows about 2,000 ft from the lower end of Unit 16B to the confluence with Spring Creek. Stream substrate measured in Spring Creek about 800 feet downstream of Tributary 4 showed only 7% fines (silt/clay < 2 mm diameter) and noted that flow from Tributary 4 accounted for about 1% of the total flow in Spring Creek (estimate of 0.005 cfs or about 2 gallons/minute). Water temperature at the mouth of Tributary 4 was 52 ^{o}F at 10:50 on August 01, 2013. The ability of the stream to transport temperature downstream is very limited due to low volumes of water this tributary delivers during the annual peak of water temperatures (late July-early August) and water temperature effects from the proposed thinning would be negligible.

Water temperatures measured by hand and thermographs from upper Phillips Creek show that the stream is capable of attaining state water quality standards (and by default PACFISH standards) even after several stands were clearcut along the main channel and headwater tributaries (Andrus and Middel 2003). Thermograph data from East Phillips Creek indicates that state water quality standards are not being attained every year. Thermograph data from Phillips Creek at the forest boundary indicate state water quality standards are being attained, although summer temperatures at this site reflect influent groundwater rather because there is no upstream surface water contribution. Hand grab water temperatures from perennial portions of Dry Creek indicate that water temperatures are being maintained to support salmonid populations.

Streamflow and temperature data are not available for other small headwater streams in the project area. These small tributaries have very limited ability to transmit heat energy downstream. The combination of no removal of shade from the primary shade zone, local ground water influence that maintains perennially flowing segments in Dry Creek and Phillips Creek, and low volume of flow from tributary streams would protect downstream water temperature from any effects of thinning in the RHCAs of these units. Ongoing water temperature monitoring would be continued in East Phillips Creek and used to evaluate the effects of the RHCA treatment on water temperature.

Guidance, developed by the Region (USFS-BLM 2005) with the support of Oregon Department of Environmental Quality (ODEQ 2005) would be followed to insure that trees within the primary shade producing zone Class I and III streams would remain. The concepts and models used in the Temperature Strategy for the Northwest Forest Plan (USFS and BLM 2012) area would be applicable to the Thomas Creek Project area. The temperature strategy, put forth by the Region, defines the width of the primary shade zone based on tree height, distances from the stream, and slope. In RHCAs only smaller diameter trees (height varies based on distance from stream – see RHCA Design Features) would be removed between 15 - 35 ft and no trees would be felled within 15 ft of Class I and III streams (see Tables 42 and 43).

One objective of the Thomas Creek Project is to thin dense stands within RHCAs to help restore ecological health and forest resiliency by actively managing stands toward HRV. FEMAT (1993) concluded that, at the local scale, shade is controlled by about 1 tree height. Contained within one tree height are the primary and secondary shade zones (Figure 5). The approach described in the Northwest Forest Plan Temperature TMDL Implementation Strategy (USFS-BLM 2012) would be used to identify primary shade zones and guide thinning in RHCAs along Class I and III streams. The NWFP Temperature Implementation Strategy has been approved by the USFS Region 6 Office, ODEQ, and BLM. Although this temperature modeling study was designed for Northwest Forest Plan streams, the same concepts and principles of shade science were applied to streams in the project area managed under PACFISH.

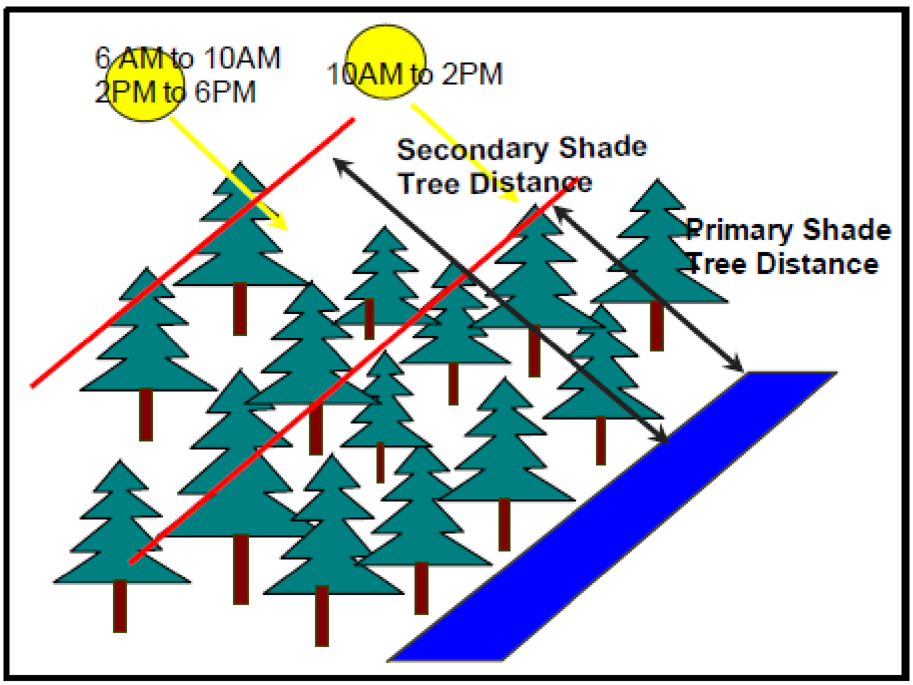

Figure 5. Relationship of primary and secondary shade zone (USFS and BLM 2012)

Thinning in RHCAs to reduce tree density has the potential to reduce angular canopy density (ACD), thus increasing solar radiation input to a stream. ACD is a measure of canopy closure (in percent) and measures the quality of the shadow the canopy provides. The Strategy describes shade science and the concept of ACD. Vegetation that intercepts solar radiation between 10:00 a.m. and 2:00 p.m. is critical for providing shade and this vegetation constitutes the primary shade zone. This vegetation also provides shade throughout the day. If the tree density in the primary shade zone is high, then trees in the secondary shade zone will add little to no additional stream shade. The Strategy is developed with conservative guidelines for determining the width of the primary shade zone (Table 35).

Table 35. Width of primary shade zone based on tree height and slope

Tree Height	Hillslope < 30%	Hillslope 30 – 60%	Hillslope > 60%
< 20 ft	12	14	15
20 – 60 ft	28	33	55
60 – 100 ft	50	55	60
100 – 140 ft	70	75	85

Using Table 35 as a guide, for example, a unit with a slope of < 30% and average tree height of a plantation tree is about 60-70 feet, then the primary shade zone would extend 50 feet from edge of the streambank. Trees outside of the primary shade zone (> 50 feet from the channel) would not be as effective at shading the stream channel. The Thomas Creek Project would modify the width of the primary shade zone as summarized in Tables 36 and 37.

Table 36. Treatments in Class I RHCAs

Height of trees to be cut	Treatment Zone Width (ft)[1] Hillslope < 35%	35 – 60%	> 60%	Silvicultural[2] Treatment	Fuels[3] Treatment
none	0 -15	0 - 15	0 - 15	No treatment	BF
< 20 ft	15 - 35	15 - 35	15 - 55	Hand thin	BF, LS
< 60 ft	35 - 75	35 - 75	55 - 75	Hand thin	BF, LS
< 60 ft	75 – 300	75 – 300	85 - 300	Hand thin	BF, FL, HP, LS, L

[1]width extends from the edge of the stream bank (Refer to Design Features Table for skidding distance specs); [2]thinning treatments would be consistent with Forest Plan Standards for shade (pg 4-60) and Upper Grande Ronde TMDLs for temperature, sedimentation, and dissolved oxygen and the Umatilla River Basin biological criteria TMDL; [3]Fuels: BF-Backing Fire; HP-Hand Pile; LS-Lop and Scatter; MP-Machine Pile; Lighting-L; Fire Line-FL [4]Ground-based: Skidder, Feller-Buncher, Harvestor-Forwarder

Table 37. Treatments in Class III RHCAs

Height of trees to be cut	Treatment Zone Width (ft)	Silvicultural Treatment	Fuels Treatment
Hillslope < 35%			
no trees cut	0 -15	No treatment	BF
< 20 ft	15 - 35	Hand thin	BF, LS
< 60 ft	35 - 75	Hand thin, cable yard	BF, LS
< 60 ft	75 – 150	Hand thin, ground based[4]	BF, FL, HP, LS, L, MP
Hillslope 35 – 60%			
no trees cut	0 - 15	No treatment	BF
< 20 ft	15 - 35	Hand thin	BF, LS
< 60 ft	35 - 75	Hand thin, skyline	BF, LS
< 60 ft	75 - 150	Hand thin, skyline	BF, FL, HP, LS, L
Hillslope > 60%			
no trees cut	0 - 15	No treatment	BF
< 20 ft	15 - 55	Hand thin	BF, LS
< 60 ft	55 - 85	Hand thin, skyline	BF, LS
< 60 ft	85 - 150	Hand thin, skyline	BF, FL, HP, LS, L

These guidelines were incorporated into the design elements for the Thomas Creek Project RHCA treatments. The area managed for stream temperature is the zone within 75 ft of Class I and III streams. No trees would be felled within 15 ft of a stream. Between 15 ft and 35 ft from a streambank only small diameter trees less than 20 ft tall would be hand felled in order to release alder or larger conifers. Between 35 ft and 75 ft from a streambank only trees less than 60 ft tall would be hand felled. This design feature would strictly follow the guidance in the Northwest Forest Plan Temperature TMDL Implementation Strategies (USFS-BLM 2005).

Park et al (2008) validated the primary shade zone width shown in Table 35 for 60-100-ft tall trees using a digital camera and widely available software to generate a light histogram for a dense Douglas-fir stand in western Oregon. They cautioned that the primary shade zone widths shown in Table 41 would not be appropriate for less dense stands, because, as stand density decreases, a larger width is needed to achieve the same ACD found in a denser stand.

Treatment units in the Thomas Creek Project were selected because of high stand densities. To determine how much (if any) to thin, shade measurements would be taken to determine existing shade. Thinning in the secondary shade zone would be based on the capability of the primary shade zone to meet Forest Plan and TMDL shade requirements. By ensuring that ACD is maintained in a stand, the risk of reducing effective shade can be minimized. Therefore, if there is no effect to shade and if shade is the main driver of stream temperature, then there would be no effect to water temperature. By using this strategy, no stream shade producing vegetation would be removed along perennial streams, thus meeting the requirements of the Clean Water Act. Water temperature will be maintained and the conditions that allow growth of shade-producing vegetation will not be retarded by implementation of any action alternative.

The Deschutes National Forest successfully implemented the Strategy to thin overly dense ponderosa pine stands along a perennial stream that is water quality limited for temperature. Post-harvest monitoring reported no detectable change in ACD after riparian thinning (Press 2014). Figure 6 shows a general concept of how the RHCA treatments would be implemented for the Thomas Creek Project.

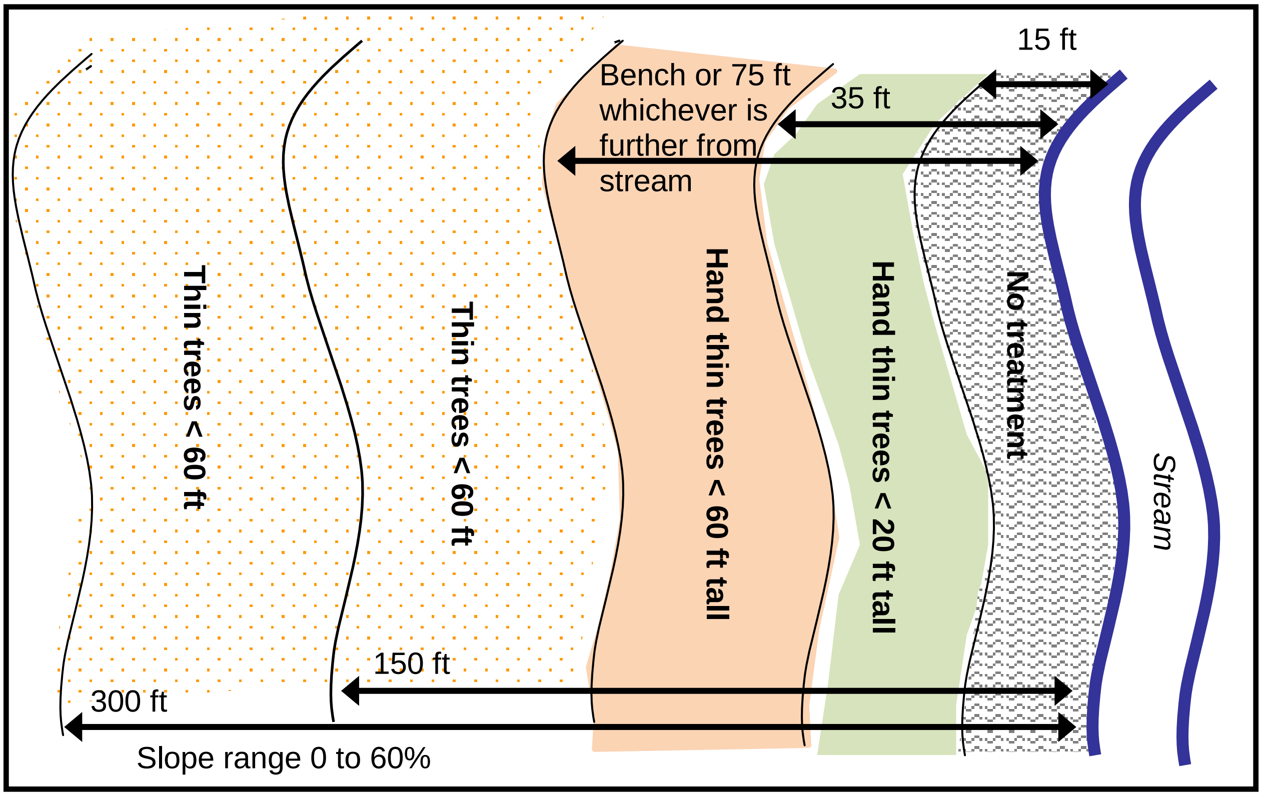

Figure 6. General RHCA prescription for Class I and III RHCAs.

Sedimentation

Measure: RHCA road density; roads in RHCAs; number of road-stream crossings; turbidity

Soil erosion occurs naturally, but can be accelerated by management activities or natural disturbance agents that reduce or remove vegetative ground cover and canopy cover or both. Other site factors influencing erosion rates include the presence and amount of rock fragments, the susceptibility of the surface soil to erosion, and local topography.

Silvicultural ground disturbing activities which may result in runoff include harvesting operations, road maintenance, construction and use, mechanical site preparation and prescribed fire. The most common sources of accelerated erosion rates associated with timber harvest are the development of roads and skid trails and removal of ground cover by harvest activities, site preparation, slash disposal operations or by high intensity fire effects under burn piles. Potential downstream effects are increased where these activities impinge on unchanneled swales or low order stream channels.

Effects to sedimentation are expected to be limited when best management practices (BMPs) and other design features are implemented. Effects will be analyzed by comparing the effects of natural background sedimentation (Soils Report), existing RHCA road system, proposed miles of RHCA log haul, thinning and mechanical fuel treatments in RHCAs, activity fuel treatments in RHCA, and landscape prescribed burning.

<u>NonCommercial Thinning</u>: Noncommercial thinning of 1,276 acres would occur by hand and there would be no ground disturbance and therefore no erosion or sediment from this activity.

Harvest and Treatments: Harvest systems and fuels treatments are summarized in the EA.

Alternative B would commercially harvest trees from within 28 acres of Class I RHCAs and 155 acres of Class III RHCAs. Sedimentation into streams from activities associated with Alternative B would be mitigated by implementation of design features identified in Attachment 5. Minimal detrimental soil acres would occur in RHCAs and haul road effects would be mitigated when design features are implemented.

Although disturbance and compaction could occur in the Riparian Habitat Conservation Areas from low impact ground based equipment, it would not be to the magnitude, extent, or duration to cause sedimentation in to enter stream channels. The allowable impacts of equipment that could be used for thinning are described in the Soils Report. Protection of soil resources is provided by the use of BMPs that minimize the potential for soil disturbance. Because project activities have the potential to affect hillslope erosion and sedimentation, surface erosion modelling was used to inform design features to protect soils and minimize sedimentation. These design criteria would prevent damage that could contribute to erosion and sedimentation into channels and streams.

Conventional tractor logging systems with tops attached to the last log would have the potential for more soil disturbance than forwarder or skyline operations. For tractor skidding the impact would be near 100% of the trail prism in DSC. Average trail spacing would be 100 feet, which would help to reduce the overall quantity of disturbance. The expectation of a forwarder operation from a soils perspective is to have less DSC impact, due to the ability to ride on slash and direct contact between tires/tracks and surface soils would be reduced. In addition, woody material would also be incorporated into the forest floor, which would serve the dual purpose of reducing fuel height and maintaining nutrients on-site. Mulching with logging slash and/or water bars would prevent surface erosion from leaving treatment units. Slope gradients would not exceed 35% on ground-based harvest units.

Skyline systems are low disturbance systems with average trail spacing about 100 feet apart and at least one-end suspension. Ground disturbance in corridors would be expected from the bottom of the unit to the landing, one to two meters wide. Erosion control consisting of waterbars and mulching where surface roughness was not sufficient to divert water from the corridor would reduce erosion but not eliminate erosion potential. Corridors typically fan out from a tower setting and do not concentrate runoff beyond their individual drainage. Generally infiltration would occur before surface runoff accumulated to the degree necessary for erosion. Waterbars would drain corridors at spacing which would normally prevent the development of erosive surface velocities. The combination of limited drainage area and erosion control would reduce and generally prevent surface erosion. Surrounding undisturbed vegetation and RHCA protection would prevent transport of any eroded sediment into surface waters.

Logging activities that are conducted on frozen ground or over snow can greatly reduce or eliminate soil compaction effects, even on soils with low bearing strength. Designated skid trail location and directional falling or falling to the lead are practices that can be effective in reducing soil compaction effects by limiting the total area subject to compaction. Implementation of appropriate BMPs, such as designated skid trails, operating under dry, frozen or snow covered conditions would reduce the potential for soil compaction and displacement.

Heavy equipment trails have the potential to impact ephemeral streams by introducing fine sediment. The fine sediment may be carried downstream during rainfall and runoff flows. The trails may also capture the ephemeral flows, and begin to function as Class IV streams. Ephemeral streams are protected from these impacts by Design Criteria (Attachment 5). Skidding up and down ephemeral streams would be prohibited and equipment crossing ephemeral draws that do not classify as Class IV will be confined to designated crossings. Sites would be chosen to avoid, minimize or mitigate potential for erosion and sediment delivery to nearby. Trees within these swales may be cut unless there are defined channel banks. If there are defined banks, the trees that support the banks would not be cut. Cut trees may be removed by dragging or lifting out, as long as equipment does not skid up and down the stream. If crossing swales during runoff is anticipated, culverts, bridges, and/or rock/earth work would be used to stabilize and armor channel banks and bottoms and prevent erosion.

The Soils Report predicted that under Alternative B approximately 4 acres of soil would be detrimentally impacted across the entire project area and it would be concentrated at trails and landings. PACFISH (1995) reported that the effectiveness of RHCAs in influencing sediment delivery from non-channelized flow was highly variable and concluded that the interim RHCA widths were adequate to protect streams from non-channelized sediment inputs. Soil erosion modelling (see Soils Report) based on soil texture, hillslope gradient and local climate determined that tractor skidders or forwarder operations should operate no closer than 75 feet to the edge of the bankfull stream channel or inner gorge (which ever provides the greater distance from the stream) to provide the margin of safety needed to prevent activity generated sediment from entering into streams. RHCA mineral soil exposure would be limited to 10% or less (Forest Plan standard) and landings would occur outside of the RHCAs. Measurable effects to sedimentation at the subwatershed and stream reach scale from this project are unlikely.

Rashin et al (2006) evaluated effectiveness of sediment BMPs in Washington State and found that stream buffer practices were most effective where timber falling and yarding activities were kept at least 10 m (33 feet) from streams and outside of steep inner gorge areas and where skid trails and cable yarding did not cross streams. They recommended that where selective harvest occurs within buffers or streamside management zones, BMPs for directional tree falling and yarding and slash disposal techniques that avoid or minimize disturbance of soils, residual riparian vegetation, and stream channels should be applied to all stream types. Other long term functions of riparian zones, such as maintenance of stream temperatures and large woody debris regimes, should also be considered in the design of stream buffers.

The High Ridge Evaluation Area study demonstrated the effectiveness of vegetated buffer strips for tractor yarding (Helvey and Fowler 1995). The first entry in 1976 included ‘wide’ buffer strips. Although ‘wide’ was undefined, aerial photo analysis indicates that buffer were variable and ranged from 100-300 feet in watersheds 1 (43% clear cut) and 4 (22% patch clearcut), with no buffer in watershed 2 (50% shelterwood). During the second entry in 1984 the rest of watershed 1 was clearcut (including the buffer), watershed 2 (50% shelterwood) was not buffered and the lower half of the stream in watershed 4 (38% patch clearcut) was buffered about 100-300 ft (air photo interpretation). Compared to pre-harvest conditions, suspended sediment yield from watersheds 1 and 2 during the first 3 years after the 1984 harvest increased by factors of 5 and 17, respectively. Sediment yield gradually declined and by 1995, yield from the logged watersheds was lower than from the control, due to luxuriant herbaceous growth. Even with several-fold increase in sediment, results indicated that sediment production and turbidity levels are within the range of values for undisturbed watersheds.

Gill (1996) found no statistically significant increase in sediment yield following road construction (25 miles), logging (1100 acres tractor/175 skyline) and burning (800 acres broadcast, 150 acres grapple pile) on volcanic ash soils at the Starkey Experimental Forest (mean elev = 4190 ft, mean slope 16%, mean annual precip = 20 inches). Sediment samples were collected in higher elevation ephemeral and intermittent streams during spring runoff for three years. Overall, annual sediment yield was low, at 0.1 – 0.7 tons/mi^2 (max = 3.7 tons/mi^2). Gill did not report the nature or extent of buffers or timing of road construction or logging.

<u>Danger Tree Removal</u>: This activity would occur along haul routes. Danger trees felled inside RHCAs would be left on the ground and no ground disturbance would occur. Removal of danger trees outside of RHCAs could lead to ground disturbance as equipment traveled off road or trees were winched to the

road. Slope distances would be short and erosion and sedimentation would be unlikely. Undisturbed RHCAs would protect channels and surface waters from sedimentation that might occur.

Roads: The Walla Walla District roads manager has assessed the condition of routes intended for haul for this project and has estimated the miles of road needing maintenance, reconstruction and temp road construction (see Transportation Report). Maintenance, reconstruction and construction would be performed using standard specifications to accomplish surface blading, hazard tree removal, construction of drainage dips or water bars, dust abatement with water, surface rock placement, roadside brushing, ditch cleanout, culvert maintenance or removal and replacement, road surface shaping and draining, surface material processing and erosion control. The BMPs, design features and applicable road maintenance specifications (EM-7730-20) meet or exceed all requirements of State or Oregon for mitigating and minimizing environmental impacts of road maintenance and road construction under OAR 629-625-0000 (ODF 2015).

The WEPP Road module (USFS 1999b) was used to compare haul-related road surface runoff among alternatives. The model calculates an amount of sedimentation leaving the road surface based on inputs of local climate, soil texture, road design, road surface material, length and width of contributing road surface and road, fillslope and buffer gradient and length (see Attachment 7 for WEPP results and input variables). The model is sensitive to the input variables. For example, changing the buffer distance from 50 to 100 feet reduces the amount of sediment by 75%. Therefore, the numbers in the table are not absolute, rather they show elevated levels of sedimentation at stream crossings due to increased traffic. The Forest Service mitigates potential negative impacts to the road surface through enforcement of contract provisions that require log haul to be suspended when wet weather conditions make continued haul unsafe, would contribute to stream sedimentation or would threaten the integrity of the road surface or subgrade. Design features such as adding spot surfacing and blading ditches only where needed, would further mitigate the adverse effects of wet weather or winter haul.

Temporary roads are constructed on stable soils and are intended for project use only. To minimize impacts to soil and water resources, pre-existing temporary road alignments and alignments of previously decommissioned system roads would be used. New temporary roads are proposed to access landings where existing system roads or existing alignments are not adequate. After use, newly constructed temporary roads would be obliterated by reestablishing former drainage patterns or natural contours, installing waterbars (if needed), removing gravel surfacing, decompacting road surfaces, pulling back unstable fill slopes or shoulders, scattering slash on the roadbed, applying erosion control much, seeding disturbed areas and blocking or disguising the former road entrance to prevent motorized vehicle traffic.

Road maintenance on haul routes would clean culverts, maintain ditches as needed, blade and shape roads, and spot rock weak road beds. These activities would improve road drainage and reduce connectivity of the road system with the drainage network. Although blading road surfaces and ditches and cleaning culvert inlets increases erosion potential in the short-term (days to weeks), these actions also result in the longer term stability of the road surface and prism, which lowers the risk of road failure due to high runoff events, and, therefore results in lower sediment yield during the long term (years). The proposed action may cause a short term (hours to days) increase in turbidity during road construction when mineral soil is first exposed and at greatest risk of being transported off-site during a rainfall event. Reduction in connectivity between the road system and the drainage network would reduce existing and potential effects to timing of runoff and sediment transport from road surfaces, ditches and cutbanks.

Road maintenance would occur on 46.6 miles of system roads used by timber sales and would include blading, ditch relief culvert cleanout, and ditch cleanout as needed on portions. Culvert cleanout and necessary ditch cleanout would lead to immediate reductions in risk from the road system. Closed roads would be left in a self-maintaining condition. Detrimental effects from ditch cleanout would be short term, less than one year.

Road reconstruction is needed for 13.6 miles of maintenance level (ML 1) roads (see Transportation Report). ML 1 roads are part of the National Forest road system and are closed to public and administrative use most of the time. These roads can be re-opened for limited duration to accomplish missions. After use, ML 1 roads would be hydrologically stabilized and re-closed to provide long-term stability and minimize future erosion from the road surface.

ML 1 roads that will be temporarily opened for this project occur mostly outside of RHCAs. Approximately 1.5 of 13.6 miles of temporarily opened ML 1 roads occur in RHCAs. Maintenance Level 1 roads, by definition, are National Forest System roads that are closed to public and administrative use, but can be temporarily re-opened for use at any maintenance level. As part of the managed road system, the intent is to conduct basic custodial maintenance to perpetuate the road for future resource management needs.

Access to unit 16B via FR3145 would require a culvert to be installed across a Class IV stream. The original culvert was removed when this road was closed. The culvert would be appropriately sized per standard engineering design. A seep occurs in the channel bottom just upstream of the culvert crossing, although the channel bottom at the proposed culvert location was dry during a field visit in August 2014. Per BMPs, road reconstruction and culvert installation would occur under dry conditions and no disturbance would occur outside of the existing footprint.

Approximately 1.0 mile of new road construction is proposed in Alternative B (Table 38). Two short routes would be constructed into Unit 45 from FR31, would be temporarily opened and ‘brushed out’ during reconstruction. Brushing out new temporary roads during reconstruction or construction would occur along 0.19 miles of newly created routes in Class IV RHCAs. Approximately 0.25 miles of temporary road into Unit 41occurs on the existing prism of former FR3200139, which includes about 0.01 miles of Class IV and 0.03 miles of Class III tributary to Thomas Creek.

Table 38. New Temporary Roads Proposed for the Thomas Creek Project – Alternative B

Unit	Length (feet)	Route in RHCA (ft)	Comment
Dry Creek Subwatershed			
34	1,160	1,160 (Class IV)	New disturbance; spur off of FR3200135; Dry Creek tributary
Phillips Creek Subwatershed			
20	1,200	0	Existing disturbance; spur off of FR31
Thomas Creek Subwatershed			
16A	420	0	New disturbance, spur off of FR3145015
41A	1,370	50 (Class IV)	Existing disturbance; former FR 3100239; Thomas Creek tributary
45	220	0	New disturbance, spur off of FR31
45	800	0	New disturbance, spur off of FR31
Total length	5,170 (1.0 mi)	1,370 (0.25 mi)	

Motorized trail O-3200135 (former road 3200135) accesses Unit 34 and closely parallels the Class IV stream in the draw bottom that bisects the unit. This route currently receives little (if any) ATV use and re-opening the road for access would not be consistent with BMPs. A new temporary road would be constructed to access Unit 34. The proposed route into the unit would occur in the outer 75 feet of the 100 foot RHCA on the south side of the channel, which would allow a 75-foot no ground disturbance buffer, consistent with sediment BMPs.

There would be log haul on approximately 15 miles of roads within RHCAs. Erosion on these roads would be more likely to increase suspended sediment in streams than haul outside of RHCAs. Roads inside RHCAs and with culvert problems are the most likely to contribute sediment to surface waters currently. Because of the design criteria, it is not expected that the activities in RHCAs would cause measurable increases in sedimentation.

Haul routes by road maintenance levels are shown in Table 45 and Table 39 shows haul routes that would occur in RHCAs. Table 40 further breaks the haul routes in RHCAs out by stream class. More than half of the haul route miles in RHCAs are FR3738 along Phillips Creek (including about 2.5 miles of non-NFS road under maintenance agreement). This road receives moderate to high use by wood cutters and recreationists. FR3738 is surfaced, but wash-boarded and pot-holed and has been under deferred maintenance for years. Needed maintenance would restore proper drainage and minimize the concentration of flow in wheel ruts, thereby reducing road surface erosion.

Table 39: Haul Routes (miles) by Maintenance Level – Alternative B

HUC6	ML1	ML2	ML3	ML4	ML5	Temp	
Dry Creek	3.9	8.1	---	1.1	1	0.2	14.3
Phillips Creek	4.2	13.4	---	---	0.5	0.2	18.3
Thomas Creek	5.5	2.0	0.4	1.5	2.8	0.6	12.9
	13.6	23.5	0.4	2.6	4.3	1.0	45.6*

*miles are clipped to these subwatersheds, 0.2 miles are in the Meacham Creek HUC6

Table 40: Haul Routes (miles) in RHCAs by Maintenance Level – Alternative B

HUC6	ML1	ML2	ML3	ML4	ML5	Temp	
Dry Creek	0.7	2.2	---	---	---	0.2	3.2
Phillips Creek	0.3	10.3	---	---	---	---	10.6
Thomas Creek	0.4	0.4	---	0.3	---	0.1	1.2
	1.4	12.9	---	0.3	---	0.3	15.0

Table 41: Haul Routes (miles) in RHCAs by Maintenance Level – Alternative B

Subwatershed	Class	Maintenance Level					
		1	2	4	5	Temp	
Dry Creek	I	0.1	1.5	---	---	---	1.6
	III	---	---	---	---	---	---
	IV	0.6	0.7	---	---	0.21	1.6
Phillips Creek	I	---	9.4	---	---	---	6.8
	III	---	0.3	---	---	---	0.3
	IV	0.3	0.5	---	---	---	1.1
Thomas Creek	I	---	---	---	---	---	---
	III	---	---	---	---	0.07	0.07
	IV	0.4	0.4	0.3	0.02	0.01	1.2
	I	0.1	10.9	---	---	---	11.0

All	III	---	0.3	---	---	0.07	0.37
	IV	1.3	1.6	0.3	0.02	0.22	3.44
		1.4	12.8	0.3	0.02	0.29	15.0

Stream crossings by subwatershed are summarized in Table 42. Use levels from log hauling would increase on 13.6 miles (26 crossings) of ML1 roads, 23.5 miles of ML2 roads (69 crossings), 2.7 miles (2 crossing) of ML4 roads and 4.3 miles of ML5 roads. Prior to and during log haul, roads would be maintained to engineering standards necessary to bear the increased loads and traffic. Project design features include suspending haul during wet conditions to limit rutting and sediment transport from road surfaces.

Table 42: Road-Stream Crossings (number) by Maintenance Level – Alternative B

Subwatershed	Class	Maintenance Level				
		1	2	4	5	
Dry Creek	I	2	1	---	---	3
	III	1	--	---	---	1
	IV	11	9	---	---	20
Phillips Creek	I	---	4	---	---	4
	III	---	3	---	---	3
	IV	6	44	---	---	50
Thomas Creek	IV	6	8	2	---	16
All	I	2	5	---	---	7
	III	1	3	---	---	4
	IV	23	61	2	---	86
		26	69	2	---	97

Road surfacing stabilizes the running surface and minimizes erosion of surface fines. Most of the haul roads that occur in RHCAs are surfaced with aggregate (Table 43). Native surface roads account for about 11% of the roads and 19% of stream crossings in RHCAs of haul routes. Because native surface roads often have a higher risk of eroding, design features would add spot-surfacing at road-stream crossings where needed to minimize erosion from the road surface.

Table 43: Haul Routes (miles) in RHCAs - Surfacing Summary – Alternative B

Subwatershed	RHCA	BST	AGG	INS	NAT	
Dry Creek	Road miles	---	0.6	2.3	0.3	3.2
	Road Crossings	---	7	15	2	24
Phillips Creek	Road Miles	---	9.6	0.1	1.0	10.7
	Road Crossings	---	44	1	12	57
Thomas Creek	Road Miles	---	0.3	0.6	0.4	1.3
	Road Crossings	---	2	10	4	16

BST – paved; AGG-crushed aggregate; INS-improved native surface; NAT-native surface

Road maintenance, reconstruction and construction would loosen surface soils, which would increase the short term risk of sediments being mobilized during rainfall. The WEPP Road module was used to illustrate the potential for sediment increase at road-stream crossings due to higher traffic patterns associated with log haul. Model results are in Attachment 7. This potential increase in sedimentation would be mitigated by design features, such as only allowing log haul under dry or frozen conditions and that spot surfacing is needed at stream crossings.

Erosion and sedimentation effects of log haul on forest roads have been the subject of numerous studies. Log haul has been demonstrated to increase sedimentation from hydrologically connected roads during precipitation events, with the effect decreasing as traffic is reduced or ends (Reid 1984). Robichaud et al (2010) summarized the effects of roads as follows. In addition to the road location, road-stream network connectivity can be increased because the concentrated runoff from can increase drainage density. For roads immediately adjacent to a stream, much of the road-generated sediment is delivered directly to the stream. When a sufficient vegetated buffer is located between the road and the stream, much of the sediment may be filtered out before runoff enters a stream channel. Dry season use of roads or restricting logging traffic during surface runoff from roads can reduce this effect by interrupting or reducing the road-stream connectivity. Design Criteria would halt log haul when turbid water leaving roadways had a potential to enter surface waters.

In a study of sediment production from forest roads, newly cleaned ditches were found to have a sediment yield substantially more than blading of the road surface or traffic use (Luce and Black 2001). This is likely due to the disruption of armored or vegetated surfaces, leading to a larger supply of fine, erodible sediment in a feature that carries water during storms. Ditch clean out would be used only when ditch function was compromised and would minimize disturbance of existing vegetation and natural armoring, practices which are common on the Umatilla National Forest. Road use restrictions and minimized ditch cleanout would reduce sediment production from road use to the extent possible. Surfacing can reduce sediment by over 400% (Burroughs and King 1985, cited in PACFISH).

Road density in Dry Creek, Phillips Creek and Thomas Creek subwatersheds is above the threshold of 3 mi/mi^2 (see Tables 14 and 20), which indicates an increased risk of runoff and sedimentation from the existing road system (McCammon 1993). Alternative B would add 0.28 and 0.21 miles of new temporary road (not previously disturbed ground) in the Dry Creek and Thomas Creek subwatersheds, respectively. This small addition of roads would increase road densities, but almost immeasurably on a subwatershed scale. These routes would be rehabilitated after use, therefore there would be no net gain in roads.

Stream crossings are used as an indicator of the degree of connectivity between the road system and the drainage network. To the degree that these roads are connected to the drainage network the risk of road sediments reaching surface waters is increased. The drainage network is lengthened and the potential for precipitation to drain more quickly, with less residence time in the watershed is increased. Within the project area, 18 of 97 stream crossings on haul routes occur on native surface roads. Timber sale road maintenance work in advance of timber sale use would add drainage features and spot rock in areas that currently erode into surface waters on haul routes. The proposed action would re-install one culvert on a Class IV stream to access unit 16B and BMPs and effects to sedimentation would be negligible.

Design features related to timing of activities and installation of physical erosion measures would minimize the risk of erosion in the short term. Road maintenance and reconstruction, followed by closing/stabilizing ML 1 roads and obliteration of new temporary roads would reduce road-related sediment during the longer term.

<u>Landscape and Prescribed Fuels Reduction Burning</u>: Jackpot and broadcast burning involve igniting concentrations of fuels on the forest floor, whether they are natural fuels or fuels resulting from a silvicultural cutting treatment (also referred to as activity fuels). Burning would occur under controlled conditions, with the objective of reducing non-contiguous areas with high accumulations of fuels. In general, burning would occur when soil moisture and large wood moisture are high, such as when the ground is still partially frozen and the snow has not completely melted. Under these conditions, large

woody material would not be completely consumed, and unburned material would remain available to decay naturally and slowly release nutrients into the soil. Burning under these conditions would also help to maintain the structure of the organic soil layer and, thereby, maintain ground cover.

Proposed landscape burning is included in action alternatives totaling approximately 984 acres. A 752 acre block occurs in the Phillips Creek subwatershed and a 232 acre block occurs in the Thomas Creek subwatershed. The Phillips Creek burn block is bounded to the west by FR3738, which would act as a fire break and leave an unburned vegetated buffer between the road and Phillips Creek. The outer part of the 300 ft RHCA, east of the road would be included in the burn area. The burn block is drained by about several intermittent 1st or 2nd order basins. These small tributaries are drained by culverts either directly under FR3738 or into the ditchline then beneath FR3738 via cross drain culverts. Flow distances from culvert outfalls to Phillips Creek range from 100-300 feet. About 30% of this burn block is non-forested. The Thomas Creek burn block is bounded to the west by a perennial tributary to Thomas Creek. The area is drained by three small 1st order intermittent (Class IV) streams. About a third of the burn block is non-forested.

The landscape units proposed for the Thomas Creek Project were chosen because they show a departure from a historic condition and prescribed fire is a viable restorative tool. Low to moderate intensity surface fire would be applied across the prescribed fire area resulting in a mosaic patchwork of fuel consumption and mortality patterns. The prescribed burns could be carried out spring or fall if conditions exist, with prescriptions designed to maintain 50% of the existing duff and to expose no more than 20% mineral soil in any blackened area (10% in RHCAs).

Several of the project design criteria are prescribed to limit the intensity of the fire as it burns, for instance; burn blocks and seasonal timing of burns. To decrease fire intensity and fire effects, ignitions will need to occur within Class IV stream channels. This allows prescribed fire specialist to control the rate of spread and flame length. If fire was to establish down slope with unburned fuels above a head fire could establish, especially on steeper slope. Head fires burn with more intensity and severity than backing fires. Ignitions within the stream channels will not be necessary where slope and fuel accumulations are minimal.

Low to moderate intensity surface fire would be applied across the prescribed fire area resulting in a mosaic patchwork of fuel consumption and mortality patterns. Low intensity underburning for this project area is defined as flame lengths ≤ 4ft which result in severities that lead to 10% or less overstory mortality. Early seral species are favored, and 1, 10, and 100 hour fuels are consumed and 1000 hour fuels are not consumed. Moderate intensity underburning for this project area is defined as flame lengths of 4-8 ft resulting in overstory mortalities of 10-25%. Early seral species are favored and 1, 10, and 100 hour fuels are consumed and 50% of thousand hour fuels are consumed. Most overstory mortality will be a result of single tree torching due to heavy ground fuel concentrations, ladder fuels and/or mistletoe. There may be few areas of group torching but these areas are estimated to be less than ½ acre in size and estimated not to exceed 5% of timbered areas. No created openings are expected to occur in RHCAs of perennial and fish-bearing streams.

The major factor that determines the effects of burning on runoff and erosion is the amount of disturbance to the surface organic material (duff) that protects the underlying soil (Robichaud et al 2010). The amount of duff consumption during prescribed fires is controlled primarily by the thickness and water content of the duff prior to burning. Erosion resulting from prescribed burning is generally less than that resulting from roads, skid trails, and site preparation techniques that cause soil disturbance (Robichaud et al 2010). They also reported that sediment effects from fuel management activities generally return to pre-disturbance levels within 1 to 2 years.

Exposed soil will occur in a mosaic pattern surrounded by unburned areas. Short slope lengths will minimize or prevent increased surface runoff and the development of flow velocities that could lead to erosion. Surrounding unburned ground cover and litter will filter and trap soils that could be eroded and prevent sedimentation. Intermittent channels will have mosaics of exposed soil interspersed with unburned ground cover and most large class down woody material, where present, will remain in these channels. No ignition in the RHCAs of fish-bearing or other perennial streams will minimize exposed soil adjacent to water. No ignition zones within 100 feet of springs and other perennial wetlands will protect riparian vegetation in these areas. Erosion and sedimentation are expected to be minor. The results of hillslope sediment modeling summarized in the Soils Report indicate that hillslope erosion due to harvest treatments and prescribed fire would remain below the background rate of 18 tons/mi^2.

Reduction in cover and increased bare soil would lead to greater sensitivity and risk of erosion in the short term. The largest potential impact comes from the risk of localized high intensity rainfall soon after burning. Increased sensitivity and risk begin to decrease very quickly due to litterfall. However the increased sensitivity and risk would continue through the first growing season until ground cover is reestablished. The mosaic of unburned vegetation in channels and the current levels of debris and other roughness would slow and reduce the transport of any sediment that does enter channels from these activities. There is a low risk that sedimentation would occur at levels that would measurably affect water quality or deposition in channels. This risk would not extend beyond the first growing season due to regrowth of surface vegetation and accumulation of natural mulches.

No ignition would occur in Class I and III RHCAs during fuels treatments, although fire would be allowed to back into them where they are adjacent to prescribed fire. There would be very little effect to existing down material and vegetation density in near channel positions. The potential for sediment to reach channels from these treatments is negligible.

<u>Large Wood Placement</u>: Woody material would be placed in the stream during low flow conditions, which would minimize sedimentation and turbidity due to bank and bed disturbance. The project plan would draw from existing and collected on-site hydrologic and geomorphologic features including channel dimensions, streamflow, sediment and bedload dynamics, woody debris and vegetation ecology. An erosion control plan would be developed as part of the project design. Pursuant to project implementation, all necessary permits (e.g. CWA Sec. 404/401) and clearances would be obtained. Design features associated with wood size, configuration and placement would conform to OWEB, ODF/ODFW and NMFS ARBO II (2013) standards. Some channel adjustments would occur in the vicinity of large wood placements, as a result of the first high runoff events after construction. High flows that occur during spring snowmelt or rain-on-snow events are naturally high in turbidity and would likely mask turbidity generated as a result of large wood placement. Short term effects to turbidity from stream restoration activities are allowed under ODEQ's antidegradation policy.

Biological Criteria

Measure: macroinvertebrate communities

Increased sediment loading could impact macroinvertebrate communities directly by burying organisms and indirectly by changing their habitat. Increased streamflows could affect macroinvertebrate communities by causing scour of stream substrate, thus directly killing organisms or indirectly by changing the substrate particle size. Potential effects to macroinvertebrate communities from this alternative would not occur because the project would not adversely affect the sediment or flow regimes in Thomas Creek and other streams within the analysis area (see Sediment Effects and Water Yield Effects).

Water Yield

Measure: road density, number of stream crossings

Direct and indirect effects to water yield could occur if expansion of the road network increases landscape dissection and effectively routes water off the landscape via the road system. Additional effects could occur if road-stream interactions increase such that the road system becomes an extension of the stream network. Alternative B would add 0.21 miles of temporary road in the Dry Creek subwatershed, 0.23 miles of temporary road in the Phillips Creek subwatershed and 0.54 miles of temporary road in the Thomas Creek subwatershed. This small amount of road would fractionally increase road densities at the subwatershed scale and would increase the road density/drainage density ratio by a negligible amount. The installation of one culvert would not change the runoff patterns from FR3145 because the road surface and ditchline runoff from this route currently enters the intermittent stream where the culvert would be re-installed. Neither of these actions would significantly increase the road density or number of stream crossings at the subwatershed scale such that there would be a measureable increase in streamflow. Therefore there would be no direct or indirect effect to water yield or peak flows from these actions under this alternative.

RHCA Condition

Channel Morphology

Measure: width/depth ratio; substrate composition; pool frequency; large wood

Meeting the minimum riparian management objectives for the given attributes is a first step in recovery of degraded stream systems. PACFISH directs that, for habitats at or better than the objective level, to maintain at least the current condition. Actions that degrade, prevent the attainment of or retard RMOs are not consistent with PACFISH goals. Table 25 summarized RMOs for streams surveyed within and downstream of the project area, along with the dominant Rosgen stream type for that reach. Except for Thomas Creek, the reported bankfull width/depth ratios are appropriate to the stream type with respect to the valley type in which the stream resides (see Attachment 1). Thomas Creek Reach 1 types to an F2b/F3b, which, in this setting, appears to be quasi- stable stream types, however, they represent a disequilibrium state from the pre-1996 flood stream morphology. Phillips Creek Reach 2 has reduced by about 30% during the past 20 years and the ratio of 32 indicates the channel is laterally stabile.

There would be no direct effects from timber harvest, thinning or burning to channel morphology because these activities would not occur within the bankfull channel. Proposed treatment within RHCAs would move stand structure and composition toward HRV and improve in-stream fish habitat. Treatment of riparian zones was identified as a need to enhance hardwoods. Enhancing hardwoods by removing competing conifers and/or planting would provide shade in the short and longer term. Thinning of off-site ponderosa pine and thinning other overly dense conifers is expected to improve the health and resilience of the remaining stand and therefore help to maintain overstory shade for the long term. Indirect effects would occur during the long-term (decades) as a result of improved streamside vegetation stand structure and composition using silvicultural techniques aimed at maintaining a relatively even delivery of large woody debris to the channel and providing a mix of riparian tree species.

Stream channel cross section monitoring at the High Ridge evaluation site concluded that timber harvest had a minor short term influence (aggradation due to sedimentation from harvest activities along streams) on channel morphology of small headwater streams and suggested that more serious long term effects to channel stability would be due to lack of large woody debris from clearcut logging (Helvey and Fowler 1995). The Thomas Creek Project would implement BMPs such s no-skid buffer zones to ensure that heavy equipment does not operate in areas where ground disturbance is likely to mobilize sediment.

Land management during the past 100 years has altered overstory vegetation along Phillips Creek and caused a reduction of large wood. The Phillips-Gordon Ecosystem Analysis (USFS 1999a) recommended placing large woody debris in Dry Creek reach 1 and 2 and Phillips Creek reaches 1, 2, and 3 because these stream reaches had low abundance of large wood and poor to moderate fish habitat quality and low abundance of pools. The addition of large wood is needed to improve spring and winter fish habitat and contribute to long-term floodplain recovery. The ecosystem analysis also recommended restoring riparian hardwoods along Phillips Creek.

The fisheries report for the Pedro Colt Timber Sale (Crabtree 2001) identified 2 areas of Phillips Creek lacking in large woody material: 1) "from the confluence with East Phillips Creek, downstream to the Forest boundary, the stream winds back and forth between the recently acquired (formerly private) land and longstanding NFS lands. The portion of the stream flowing through longstanding NFS lands contains mostly complex, high quality, aquatic habitat. The portion within formerly private land contains very little shade or woody debris, aquatic habitat is simplified, pool frequency is low and escape and hiding cover is lacking" and 2) "Upstream of the East Phillips Creek confluence, on NFS lands, three old clearcuts extend right across Phillips Creek. Nearly all the shade and all the trees that would have formed future large woody debris were removed during harvest. Some logs left…were apparently cull and are mostly rotten and will not persist". For whatever reason, these projects were not included in the final EA and decision.

This project proposes to add wood in old clearcuts and ponderosa pine plantations along about 1.5 miles of Phillips Creek (about 20% of the fish-bearing channel). Meredith et al (2014) noted that wood inputs are one the few aspects of habitat that can be easily manipulated by land managers, partly through changes in riparian management practices and placement of wood into streams. Because streams differ in their ability to recruit, retain and accumulate wood, the most appropriate management strategy will vary by location. Based on stream type and location in the drainage network, the lower 5 miles or so of Phillips Creek is a response reach that historically would have accumulated large woody jams, with wood derived from the immediate riparian area, in addition to occasional inputs from debris flows. A geomorphic analysis would be conducted to determine location, type and amount of wood placement using NMFS ARBO II (2013) guidelines as a minimum standard.

Direct effects to stream morphology are expected to occur when large woody debris is placed into Phillips Creek by machine or by direct felling. Reintroducing roughness features (wood) would result in a more complex regime of bank and bed scour and in-channel deposition, which is expected to be closer to the historic regime. Rosgen (1996) found that channel stability and biological function of type 'B' streams is directly linked to the type, amount and extent of woody debris. He cautioned that C3 streams types (such as portions of Phillips Creek) can be adversely affected by excessive or poorly placed large woody material. Phillips Creek has evolved with inputs of large wood from the adjacent forest. Prior to placement of any woody material into Phillips Creek, a restoration plan would be developed to assess the amount, size and location of placement based on channel morphology and sediment dynamics. Thinning and leaving some conifers in the bankfull channel and the floodplain or floodprone area of all stream classes would add structure that helps to dissipate energies associated with high stream flows (e.g. spring runoff), adds to bank stability and also aids in retaining sediment to help build floodplains and provides a growth medium for bank stabilizing vegetation.

Effects to RMOs at the habitat scale may be realized with the addition of large wood and riparian woody vegetation in Phillips Creek and other streams as directed by the watershed specialist. Effects to other streams would remain unchanged at the habitat, reach and watershed scales.

Riparian Soil Condition

Measure: RHCA road density; roads in RHCAs; number of stream crossings; detrimental soil condition in RHCAs

Alternative B would add 0.25 miles of new temporary road into a Class IV RHCA and would install one culvert on a ML-1 road within a Class IV RHCA at the location where the culvert was previously removed. The proposed access route into Unit 41B includes 0.03 miles of Class IV RHCA on an existing road bed. A new temporary route would be constructed into the outer 75 feet of Unit 34. Sediment modeling indicates a minimum 75 foot buffer distance is needed to prevent sedimentation in the intermittent stream (see Soils Report). RHCA road density in Dry Creek subwatershed would temporarily increase from 3.40 to 3.45 mi/mi^2 while the road is in use. Forest Plan direction requires that temporary roads be obliterated; therefore there would be no long term effect to RHCA soil from this alternative. The number of road-stream interactions in the Thomas Creek subwatershed would not change with the re-installation of one culvert where the insloped ditch along FR3145 enters into the stream. Installation of the culvert would not increase DSC because the culvert would be installed at an existing disturbance area.

The Thomas Creek Project proposes commercial and non-commercial treatments in 5% of the RHCAs of the Dry Creek subwatershed, 7% of the RHCAs within the Phillips Creek subwatershed and 6% of the RHCAs within the Thomas Creek subwatershed (Table 44). Project design features for skidding, yarding and burning would limit DSC to < 10% (Forest Plan standard) within RHCAs.

Table 44: Alternative B - Thomas Creek Project Area RHCA summary (acres)

Subwatershed	Class I	Class III	Class IV	Total
Dry Creek	**1,041**	**693**	**1,522**	**3,256**
Non-Commercial	21	6	72	99
Commercial	0	1	64	66
Phillips Creek	**1,125**	**1,394**	**2,417**	**4,936**
Non-Commercial	151	75	105	331
Commercial	0	4	22	26
Thomas Creek	**420**	**981**	**1,306**	**2,706**
Non-Commercial	0	20	57	76
Commercial	0	23	69	92

Floodplain Function

Measure: roads in RHCAs; number of stream crossings; large wood

Floodplain function is inherently linked to stream channel and riparian condition because effects that disturb soils and cause changes to stream stability also affect adjacent floodplains and flood prone areas. There would be no direct effects from timber harvest activities because no new roads would be constructed in floodplains and landings and skidding would not occur in floodplains. The installation of a culvert at an intermittent (Class IV) stream crossing of FR3145 would be consistent with Clean Water Act Section 323.4 (discharges not requiring permits). There would be no indirect effects to floodplain function because this alternative would not change water yield, peak flows or sediment regime, thus current levels of channel stability and morphology would not be altered. Floodplain areas comprise a small part of RHCA soils and design features for cutting, skidding and yarding would protect these soils and maintain DSC within Forest Plan standards.

Installation of structures would disturb floodplain soils at individual sites and the direct effect of placing large wood would be to improve floodplain function along 1.5 miles of Phillips Creek by increasing roughness. Increased roughness would help dissipate high streamflow energies associated with spring runoff velocities, helping to maintain lateral and vertical channel stability.

Wetlands and Groundwater Dependent Ecosystems

Measure: roads in RHCAs; detrimental soil condition in RHCAs

Alternative B does not propose new ground disturbing activities in stream- or spring-associated wetlands; therefore, there would be no direct or indirect effects to wetlands as a result of this alternative.

Alternative C

Refer to *Thomas Creek Restoration Project Alternatives* description in the project record for a detailed description of the alternatives. The Vegetation Report describes the effects of this alternative to forest structure at the landscape scale. Within that landscape, this alternative would improve species composition, structural stage and density by about 12% toward the historic range of variability. As more of the landscape approaches HRV, the expected outcomes are improved forest health, vegetation vigor and ecosystem resilience to fire, insects and disease. The Fuels Report describes treatments for activity fuels and landscape fire. The landscape burning would largely be classified as low intensity surface fire (underburning) in which surface fuel reduction and mortality of understory and overstory components are commensurate with effects that could be expected to occur historically.

Summary: The direct effects of implementing this alternative would be the removal of 5.77 MBF of timber from 1,328 acres (including development of skid trails, landings and 0.75 miles of temporary road) and precommercially thinning an additional 1,270 acres. Jackpot, broadcast and pile burning would occur on about 414 acres or about 16% of the treatment area. Lop and scatter could occur on about 1,270 acres and prescribed fire is planned for an additional 984 acres.

Alternative C includes a learning design element that would add 100-ft edge treatment/monitoring areas inside and outside 23 units and would eliminate 3 units (decrease of 62 acres) as part of the experimental design. Riparian Unit 16B is also eliminated from this alternative (10 acres) because it would be the outer edge of Unit 16, which was randomly selected as a learning design unit and could not be treated like the adjacent stand because it is an RHCA. For 11 of the 23 edge treatment units there would be no treatment in the outer 100-ft edge zone. For 12 of the 23 edge treatment units there would be treatment in the inner and outer 100-ft zones, effectively increasing the size of the units by a 100-ft boundary outside the unit (increase of 136 acres). This alternative would not treat RHCAs within the outer 100 foot edge zone. Haul routes would not be needed to access Units 15A, 15B, 39, 41A and 41B, therefore, there would be 1.2 fewer miles of road needed for this alternative than for alternative B.

Table 45 shows the net gain of 74 acres of treatment area as a result of unit deletions and additions for the learning design.

Table 45: Alternative C compared to Alternative B, net increase in Treatment Area

Subwatershed	Add Acres	Subtract Acres	Net Gain (Loss)
Dry Creek	27.6	(13.6)	14.0
Phillips Creek	2.8	0	2.8
Thomas Creek	105.2	(48.1)	57.1
			73.9

Table 46 shows the change in RHCA area affected by treatment units and roads compared to alternative B.

Table 46: Alternative C compared to Alternative B, reduction in RHCA treatments and haul road impacts

Unit	Acres	RHCA acres		Road	Miles	Road in RHCA		Stream Crossing
		III	IV			III	IV	
Dry Creek Subwatershed								
39	13.5	---	1.4	3200130	0.37	---	0.05	1
Thomas Creek Subwatershed								
15A	12.0	---	---	3145020	0.36	---	---	---
15B	10.6	10.6	---	3145020	0.02	0.02	---	---
41A	17.8	---	3.0	3100239	0.16	---	0.03	---
41B	7.0	7.0	---	Temp	0.25	---	0.01	---
		17.6	4.4		1.16	0.02	0.09	1

Table 47 summarizes total RHCA acres and RHCA acres within treatment units.

Table 47: Alternative C - Thomas Creek Project Area RHCA summary (acres)

Subwatershed	Class I	Class III	Class IV	Total
Dry Creek	**1,041**	**693**	**1,522**	**3,256**
Non-Commercial	21	6	72	99
Commercial	0	1	63	64
Phillips Creek	**1,125**	**1,394**	**2,417**	**4,936**
Non-Commercial	151	75	105	331
Commercial	0	4	21	25
Thomas Creek	**420**	**981**	**1,306**	**2,706**
Non-Commercial	0	19	42	61
Commercial	0	0	75	76

Temperature and Shade

Measure: water temperature; RHCA canopy density

Changes from Alternative B include a reduction of potential Class III RHCA treatment area from 42 acres to 19 acres in the Thomas Creek subwatershed. This small change in affected area is within the scale of effects analyzed for Alternative B. Design features described for Alternative B are also applicable to this alternative for the maintenance of canopy density within the primary and secondary shade zone and therefore, no change to stream water temperatures

Sedimentation

Measure: RHCA road density; roads in RHCAs; number of road-stream crossings,; turbidity

Alternative C would result in an overall increase of 74 treatment acres compared to Alternative B. Changes from Alternative B also include a reduction of 20 acres of treatment and 0.07 miles of road within Class III and IV RHCAs in the Dry and Thomas Creek subwatersheds. Alternative C would add one temporary culvert in a Class IV stream, as in Alternative B. Unit 39 would be dropped and this would eliminate one ML1 haul route stream crossing at a Class IV stream, compared to Alternative B. Haul routes in RHCAs would be reduced by 0.1 miles in Alternative C compared to Alternative B. These small changes in affected area are within the scale of effects analyzed for Alternative B. Road maintenance and reconstruction along haul routes would decrease the potential for water to accumulate, concentrate and runoff of road surfaces, which would decrease the potential for roadbed sediment to enter into stream channels. Design features described for Alternative B are also applicable to this alternative for the protection of water quality due to sedimentation from treatment areas and haul roads.

Biological Criteria

Measure: macroinvertebrate communities

Same as Alternative B.

Water Yield

Measure: road density, number of stream crossings

Alternative C would add 0.21 miles of temporary road in the Dry Creek subwatershed, 0.23 miles of temporary road in the Phillips Creek subwatershed and 0.57 miles of temporary road in the Thomas Creek subwatershed. This small amount of road would fractionally increase road densities at the subwatershed scale and would increase the road density/drainage density ratio by a negligible amount. The installation of one culvert would not change the runoff patterns from FR3145 because the road surface and ditchline runoff from this route currently enters the intermittent stream where the culvert would be re-installed. Neither of these actions would significantly increase the road density or number of stream crossings at the subwatershed scale such that there would be a measureable increase in streamflow. Therefore there would be no direct or indirect effect to water yield or peak flows from these actions under this alternative.

RHCA Condition

Channel Morphology

Measure: width/depth ratio; substrate composition; pool frequency; large wood

Same as Alternative B.

Riparian Soil Condition

Measure: roads in RHCAs; RHCA road density; number of stream crossings; detrimental soil condition in RHCAs

Effects would be slightly less than described for Alternative B because only 0.75 miles of temporary road would be constructed and there would be a reduction of 20 acres of treatments in Class III RHCAs. Changes to RHCA road density would be slightly lower than under Alternative B and effects at the subwatershed scale, when compared to Alternative B, would be negligible.

Floodplain Function

Measure: roads in RHCAs; number of stream crossings; large wood

Same as Alternative B.

Wetlands and Groundwater Dependent Ecosystems

Measure: roads in RHCAs; detrimental soil condition in RHCAs

Same as Alternative B.

Alternative D

Refer to *Thomas Creek Restoration Project Alternatives* description in the project record for a detailed description of the alternatives. The Vegetation Report describes the effects of this alternative to forest structure at the landscape scale. Within that landscape, this alternative would improve species composition, structural stage and density by about 10% toward the historic range of variability. As more of the landscape approaches HRV, the expected outcomes are improved forest health, vegetation vigor and ecosystem resilience to fire, insects and disease. The Fuels Report describes treatments for activity fuels and landscape fire. The landscape burning would largely be classified as low intensity surface fire (underburning) in which surface fuel reduction and mortality of understory and overstory components are commensurate with effects that could be expected to occur historically.

Summary: The direct effects of implementing this alternative would be the removal of 4.73 MBF of timber from 949 acres (including development of skid trails and landings) and precommercially thinning an additional 1,468 acres. Jackpot, broadcast and pile burning would occur on about 392 acres or about 16% of the treatment area. Lop and scatter could occur on about 1,468 acres or about 62% of the area and prescribed fire is planned for an additional 984 acres.

Sediment effects would be the same.

Changes from Alternative B:

1. No temporary road construction
2. Only non-commercial treatments (NCT) in RHCAs
3. Units dropped from Alt B: 15B, 16A, 16B, 20, 24, 25, 41A, 41B, 45, 55
4. Unit 92 goes from commercial to NCT
5. Class III RHCA Changes to Attachment 6:
    a. Treatment acres dropped: 15B – 11 ac; 16B – 5 ac; 20 – 1 ac; 24 – 2 ac; ac; 41B – 7 ac
    b. Treatment changes from commercial to NCT: Unit 26 – 1 ac; Unit 60 - 2 ac
6. Haul routes not needed as shown in Table 46.
7. Haul routes for Alternative D would have 10 less road crossings than Alternative B

Table 48 summarizes total RHCA acres and RHCA acres within treatment units.

Table 48: Alternative D - Thomas Creek Project Area RHCA summary (acres)

Subwatershed	Class I	Class III	Class IV	Total
Dry Creek	**1,041**	**693**	**1,522**	**3,256**
Non-Commercial	21	4	65	90
Commercial	0	0	0	0
Phillips Creek	**1,125**	**1,394**	**2,417**	**4,936**
Non-Commercial	114	77	126	317
Commercial	0	0	0	0
Thomas Creek	**420**	**981**	**1,306**	**2,706**

Non-Commercial	0	20	115	135
Commercial	0	0	0	0

Table 49 shows the change in RHCA area affected by treatment units and roads compared to alternative B.

Table 49: Alternative D compared to Alternative B, reduction in RHCA treatments and haul road impacts

Unit	Acres	RHCA acres		Road	Miles	Road in RHCA		Stream Crossing
		III	IV			III	IV	
Dry Creek Subwatershed								
24	6.3	2.1	---	---	---	---	---	---
25	15.8	---	7.1	---	---	---	---	---
34	---	---	---	Temp	0.21	---	0.21	---
Phillips Creek Subwatershed								
20	9.5	1.3	0.8	Temp	0.23	---	---	---
Thomas Creek Subwatershed								
15B	10.6	10.6	---	3145020	0.02	0.02	---	---
16A	14.1	---	---	Temp	0.08	---	---	---
16B	10.0	5.2	4.8	3145000	0.53	---	0.30	1
41A	17.7	---	3.1	3100239	0.16	---	0.03	---
				Temp	0.25	---	0.01	---
41B	7.0	7.0	---	Temp	same	---	---	---
45	16.2	---	2.9	Temp	0.05	---	---	---
				Temp	0.15	---	---	---
		26.2	18.7	ML1	0.71	0.02	0.33	1
				Temp	0.97	---	0.22	---

Temperature and Shade

Measure: water temperature; RHCA canopy density

Changes from Alternative B include a reduction of potential Class I and III RHCA treatment areas from 300 to 236 acres (compare Tables 51 and 52). Effects to shade-producing vegetation would be less than under Alternative B and this small change in affected area is within the scale of effects analyzed for Alternative B. Design features described for Alternative B are also applicable to this alternative for the maintenance of canopy density within the primary and secondary shade zone.

Sedimentation

Measure: RHCA road density; roads in RHCAs; number of road-stream crossings, Acres of detrimental soil condition in RHCAs; turbidity

Alternative D would result in an overall reduction of 298 treatment acres compared to Alternative B. Changes from Alternative B also include a reduction of 64 acres of treatment within Class I, III and IV RHCAs. Haul routes in RHCAs would be reduced from 15 miles under Alternative B to 13.9 miles in Alternative D. There would be 10 fewer haul route road-stream crossings in Alternative D, although there would be no change to the overall number of road-stream crossings in the project area. These small changes in affected area are within the scale of effects analyzed for Alternative B. Road maintenance and reconstruction along haul routes would decrease the potential for water to accumulate, concentrate and runoff of road surfaces, which would decrease the potential for roadbed sediment to enter into stream channels. Design features described for Alternative B are also applicable to this alternative for the protection of water quality due to sedimentation from treatment areas and haul roads.

Biological Criteria

Measure: macroinvertebrate communities

Same as Alternative B.

Water Yield

Measure: road density, number of stream crossings

Alternative D would have 7 fewer miles of haul roads than Alternative B however, these are existing NFS roads. Thus, there would be no change to the overall road system, therefore no change to road density and the number of road-stream crossings. Therefore there would be no direct or indirect effect to water yield or peak flows because there would be no additions or deletions to/from the road system.

RHCA Condition

Channel Morphology

Measure: width/depth ratio; substrate composition; pool frequency; large wood

Same as Alternative B.

Riparian Soil Condition

Measure: roads in RHCAs; RHCA road density; number of stream crossings; detrimental soil condition in RHCAs

Effects would be slightly less than described for Alternative B because only 0.75 miles of temporary road would be constructed and there would be a reduction of 20 acres of treatments in Class III RHCAs. Effects at the subwatershed scale, when compared to Alternative B, would be negligible.

Floodplain Function

Measure: roads in RHCAs; number of stream crossings; large wood

Same as Alternative B.

Wetlands and Groundwater Dependent Ecosystems

Measure: roads in RHCAs; detrimental soil condition in RHCAs

Same as Alternative B.

Alternative E

Refer to *Thomas Creek Restoration Project Alternatives* description in the project record for a detailed description of the alternatives. The Vegetation Report describes the effects of this alternative to forest structure at the landscape scale. Within that landscape, this alternative would improve species composition, structural stage and density by about 14% toward the historic range of variability. As more of the landscape approaches HRV, the expected outcomes are improved forest health, vegetation vigor and ecosystem resilience to fire, insects and disease. The Fuels Report describes treatments for activity fuels and landscape fire. The landscape burning would largely be classified as low intensity surface fire (underburning) in which surface fuel reduction and mortality of understory and overstory components are commensurate with effects that could be expected to occur historically.

Summary: The direct effects of implementing this alternative would be the removal of 7.41 MBF of timber from 1,793 acres (including development of skid trails, landings and 1 mile of temporary road) and precommercially thinning an additional 1,276 acres. Jackpot, broadcast and pile burning would occur on about 427 acres or about 14% of the treatment area. Lop and scatter could occur on about 1,276 and prescribed fire is planned for an additional 984 acres.

Changes from Alternative B:

1. Add 23 units (522 acres) of commercial thinning.
2. Additional 8.5 miles of haul road:
    a. Unit 131 – FR3100 - 1.8 miles of paved road; 0.2 miles of haul route in Class IV RHCA and 6 Class IV stream crossings; FR3180 – 2.6 miles ML1, 1 Class IV stream crossing, 0.2 miles of haul route in Class IV RHCA; FR3180050 – 0.3 miles ML1
    b. Unit 135 – FR3100231 – 1.1 miles ML1; 0.06 miles haul route in Class IV RHCA
    c. Unit 150 – FR 3200141 – 0.45 miles ML1; 0.13 miles of haul route in Class IV RHCA and 4 Class IV stream crossings
    d. Unit 152 – FR3217900 – 1.0 mile ML2; 200 ft of haul route in Class IV RHCA

Table 50 summarizes total RHCA acres and RHCA acres within treatment units.

Table 50: Alternative E - Thomas Creek Project Area RHCA summary (acres)

Subwatershed	Class I	Class III	Class IV	Total
Dry Creek	**1,041**	**693**	**1,522**	**3,256**
Non-Commercial	21	6	72	99
Commercial	0	1	64	66
Phillips Creek	**1,125**	**1,394**	**2,417**	**4,936**
Non-Commercial	151	75	105	331
Commercial	0	4	22	26
Thomas Creek	**420**	**981**	**1,306**	**2,706**
Non-Commercial	0	20	57	76
Commercial	0	23	69	92

Temperature and Shade

Measure: water temperature; RHCA canopy density

Riparian treatments would be the same as for Alternative B. Default PACFISH buffers would be applied to RHCAs of the additional 23 units (34 acres Class I and III RHCAs) therefore there would be no change to existing stream shade-producing vegetation within these stands. Haul routes in perennial (Class I and III) RHCAs be the same as Alternative B, therefore, the effects to shade and stream temperature would be same as for Alternative B. Because FR3738 is an open NFS road and, other than hazard tree removal, log haul would not change the amount of stream shade-producing vegetation in the RHCA.

Sedimentation

Measure: RHCA road density' roads in RHCAs; number of road-stream crossings, turbidity

Alternative E would result in an overall increase of 522 treatment acres compared to Alternative B. Compared to Alternative B there would be no additional RHCA treatment and default PACFISH buffers would be applied to all streams in these units. Sediment modeling has shown that a minimum 75 foot buffer is needed to prevent sedimentation to stream channels. The amount of new temporary road construction would be the same as Alternative B. Alternative E includes an additional 8.5 miles of NFS roads that would be used for log haul. Road maintenance and reconstruction along haul routes would decrease the potential for water to accumulate, concentrate and runoff of road surfaces, which would decrease the potential for roadbed sediment to enter into stream channels. Design features described for Alternative B are also applicable to this alternative for the protection of water quality due to sedimentation from treatment areas and haul roads. These changes in affected area are within the scale of effects analyzed for Alternative B.

Biological Criteria

Measure: macroinvertebrate communities

Same as Alternative B.

Water Yield

Measure: road density, number of stream crossings

The amount of new temporary road construction would be the same as Alternative B and the effect to road densities at the subwatershed scale would be the same as Alternative B. Installation of one temporary culvert on an ML1 road is analyzed under Alternative B. Alternative E would have 8.5 more miles of haul roads than Alternative B however, these are existing NFS roads and there would be no change to road density or number of stream crossings at the subwatershed scale. Therefore there would be no direct or indirect effect to water yield or peak flows from these actions under this alternative.

RHCA Condition

Channel Morphology

Measure: width/depth ratio; substrate composition; pool frequency; large wood

Same as Alternative B.

Riparian Soil Condition

Measure: roads in RHCAs; RHCA road density; number of stream crossings; detrimental soil condition in RHCAs

Alternative E would add 23 harvest units consisting of 522 acres. RHCAs within these units consist of 21 acres Class I, 13 acres Class III and 63 acres Class IV. Compared to Alternative B there would be no additional RHCA treatment because default PACFISH buffers would be applied to all Class I, III and IV streams in these units.

Alternative E would have 0.9 more miles of haul roads in RHCAs and 10 more road-stream crossings along haul roads than Alternative B. These additional haul routes are NFS system roads and road density from this alternative would remain the same as for Alternative B.

Floodplain Function

Measure: roads in RHCAs; number of stream crossings; large wood

Same as Alternative B.

Wetlands and Groundwater Dependent Ecosystems

Measure: acres of roads in RHCAs; detrimental soil condition in RHCAs

Under Alternative E, unit 151 has one additional mapped water source, which has not been field verified. Ground disturbing activities would not occur in stream- or spring-associated wetlands; therefore, there would be no direct or indirect effects to wetlands as a result of this alternative.

Cumulative Effects

Spatial and Temporal Context for Effects Analysis

Cumulative effects for all hydrologic indicators will be analyzed using NFS lands in HUC 6 subwatersheds. This geographic extend encompasses the area that reasonably could be affected by the Thomas Creek Project. Cumulative effects for water quality will be analyzed for short term (1 day to 1 week) and for long term (up to one runoff season). These time scales were chosen to display short term concentrated effects, and longer term seasonal effects that are sometimes seen during spring runoff.

Cumulative effects for water yield are calculated using records of timber harvest activity dating to the 1950s. The Equivalent Treatment Acre (ETA) model has a 33 year time-frame for the slowest sites to recover hydrologically (collection, storage, and release of precipitation). Although vegetation management proposed in the project may occur over a number of years, the calculation assumes all treatments occur in 1 year, and therefore shows the maximum effect that could be expected. Time frames for stream flow and water yield are 1-10 years for short term and > 10 years for long term effects.

Past, Present, and Reasonably Foreseeable Activities Relevant to Cumulative Effects Analysis

Cumulative impacts result from the incremental impact of the action **when added** to other past, present and reasonably foreseeable future actions. If there are no direct or indirect effects of the proposed action, there cannot be cumulative effects.

Past Actions

Past actions in the analysis area include grazing, fires, fire exclusion, timber harvest, road construction, road obliteration and recreation. Table 51 summarizes past timber harvest from NFS lands.

Table 51: Summary of Past Forest Service timber sale activity by decade (acres)

Decade	Thomas Creek (170701030101)	Dry Creek (170601040801)	Phillips Creek (170601041101)
1950s	602	2	431
1960s	252	71	1,377
1970s	3,222	4,276	4,629

1980s	444	414	1,762
1990s	912	185	1,701
2000s	0	601	1,001
2010s	0	0	293

A land exchange with Boise Cascade in 1992 consisted of 800 acres along lower Phillips Creek including about 2.5 miles of Phillips Creek and 0.5 miles of East Phillips Creek. The exchange also included about 145 acres along Ninemile Ridge. The Phillips Creek Fire burned about 2,600 acres in the Phillips Creek subwatershed, including about 630 acres of the Thomas Creek Project area in 2015.

Present Actions

Livestock Grazing

The analysis area is contained within the North End Sheep Allotment (Table 52). Range NEPA was recently completed for the allotment (USFS 2011) and the grazing permit is administered through the allotment management plan and annual operating instructions.

Table 52: North End Sheep Allotment

Subwatershed	Grazing Pasture (acres)	
	Phillips Creek Unit	Middle Ridge Unit
Dry Creek	6,100	---
Phillips Creek	4,518	11,661
Thomas Creek	8,427	---

Grazing season 6/01 – 10/09, rotation varies annually between subunits

Recreation

The Recreation Report describes the various forms of recreational activities that occur within the project area. Dispersed camping areas in RHCAs within the project area are summarized in Table 53.

Table 53: Dispersed Camping Areas in RHCAs

Location	Latitude	Longitude	Comment
Dry Creek			
FR3200120	45.638	-118.116	Sheep herder camp on floodplain
FR3200130	45.615	-118.111	Sheep herder camp on old road bed above floodplain
Phillips Creek			
FR3740	45.612	-118.063	In floodplain adjacent creek
FR3148	45.626	-118.073	At end of road, out of floodplain
FR3738	45.625	-118.071	Terrace adjacent East Phillips Creek, old road and landing
FR3738	45.623	-118.071	Adjacent Phillips Creek, site rehabbed in 2013

Transportation Management

Motor vehicle and recreational off road vehicle use are administered via the Umatilla National Forest motor vehicle use map (MVUM). The MVUM shows NFS roads and trails that are designated for motor vehicle use, in addition to types of vehicles and seasonal use restrictions.

Invasive Weeds Treatment

The Invasive Plants Report identifies about 2,800 acres of invasive species within the project area. Weeds treatment would continue to occur along roads and in areas described in the 2015EDRR (reference) and implementation would follow design features described in the Umatilla National Forest Weeds EIS (2010) and the Invasive Plants Report (2015).

Climate Change

The ability to maintain existing high quality habitats and to restore degraded habitats will be influenced by climate change over the next several decades with projected higher average air temperatures, more winter precipitation falling as rain versus snow, and diminishing winter snow packs resulting in earlier snowmelt. Changes in runoff volume and lower summer base flows, higher surface water temperatures, and likely greater year-to-year variability in precipitation could also result in extended drought periods and more severe floods than have occurred in recent history. Changes in timing and amount of runoff associated with climate change affect every resource, including terrestrial vegetation, wildlife, riparian and aquatic species, and water availability for human use.

Lute and Abatzoglou (2014) predict that hydroclimatic changes in the western U.S. are expected to accelerate in the coming decades as human induced changes in temperature and precipitation become more profound (Ashfaq et al 2013). Changes in snowfall accumulation combined with warmer spring temperatures are projected to result in significantly earlier snowmelt and subsequent runoff, lower summer baseflow, and decreased summer surface runoff. In the western United States, the implications of these changes for snow metrics have already been observed in the form of less precipitation falling as snow, decreased April 1 snow water equivalent, earlier snowmelt, decreased spring snow cover extent, and shortened snow cover duration. In the Blue Mountain region of the Umatilla National Forest declines of 20-30% are projected for snowfall water equivalents and number of snow days.

Cumulative Effects Common to All Alternatives

Motor vehicle and recreational off road vehicle use would continue to occur on routes designated on the Umatilla National Forest motor vehicle use map (MVUM). Erosion and sedimentation from roads would continue as roads are used and maintained according to their respective maintenance level. Continued deferred maintenance of the majority of system roads would be the primary management related sources of accelerated erosion. The current level of livestock use would continue and would be managed under the allotment management plan an annual operating instructions which allows flexibility to meet resource objectives. The Invasive Plants Report identifies about 2,800 acres of invasive species within the project area. Weeds treatment would continue to occur along roads and in areas described in the 2015EDRR (reference) and implementation would follow design features described in the Umatilla National Forest Weeds EIS (2010) and the Invasive Plants Report (2015). Natural disturbance events such as fires and floods could affect stream temperature and sediment regimes over time, if these events cause large-scale changes to vegetation or stream channel morphology.

Cumulative effects of the Phillips Creek Fire would be negligible at the subwatershed scale because current ETA is low and the moderate to high severity fire burned less than 2% of the Phillips Creek subwatershed, therefore the landscape vegetation condition remains well below thresholds values of concern for increased water yield and peak flow.

Alternative A Cumulative Effects

Species composition and structural changes at the landscape scale described in the Vegetation Report would not occur by mechanical means, therefore succession would remain on its current trajectory further away from landscape range of variation.

Water Quality

Stream temperatures would be unaffected under the No Action Alternative. Phillips and Dry Creeks would continue to exhibit discontinuous to intermittent flow regimes during the summer and fall, with influent groundwater maintaining summer water temperatures to support anadromous salmonids. Spring Creek would continue to maintain perennial flow and water temperatures would continue to exceed the threshold for bull trout. Thomas Creek would continue to exhibit intermittent flow along FR 32 until its confluence with Spring Creek and water temperature would also continue to exceed the bull trout temperature standard.

The current use pattern of roads within the analysis area would not change. Road densities and road use designations would remain unchanged with the no action alternative. Motor vehicle and recreational off road vehicle use would continue to occur on routes designated on the Umatilla National Forest motor vehicle use map (MVUM). Erosion and sedimentation from roads would continue as roads are used and maintained according to their respective maintenance level. Continued deferred maintenance of the majority of system roads would be the primary management related sources of accelerated erosion. Natural disturbance events such as fires and floods could affect stream temperature and sediment regimes over time, if these events cause large-scale changes to vegetation or stream channel morphology.

Water Yield

In Dry Creek and Phillips Creek subwatersheds with existing recent harvest, vegetative recovery through time would continue to reduce ETA values. Current ETA values for all three subwatersheds are low (< 3%, see Tables 15 and 33) compared to threshold values and suggest that there is no measurable difference between current conditions and those with no harvest. Additional growth of conifer stands into the future would not measurably change water yield or peak flows.

RHCA Condition

The hydrologic function of streams in the project area would continue to recover within the limitations of past and present management (timber harvest and roads) and periodic high flow events. Portions of Phillips Creek would remain deficient of large woody material due to past timber harvest. These stream segments would remain at higher risk to adverse channel adjustments from high stream flows due to the general lack of large woody structure. Large scale fire could affect water yield and peak flows, with resultant adverse effects to channel and riparian condition, with resultant loss of fish habitat.

Wetlands and Groundwater Dependent Ecosystems

The hydrologic function of stream-associated wetlands in the project area would continue to recover within the limitations of past and present management (timber harvest and roads) and periodic high flow events. The condition of seeps and springs in the project area would continue to be influenced by current management, as described in Attachment 3.

Cumulative Effects Common to All Action Alternatives

Water Quality

Temperature and Shade

Past actions, including road construction and timber harvest, affected overstory structure and, by default, shade which resulted in a higher exposure of surface water to solar radiation. In the alternatives, prescribed fire ignition will not occur within 300 feet either side of fish bearing streams, within 150 feet each side of perennial non-fish bearing streams, or within100 feet of springs and other isolated wetlands.

Shade will not be affected and there will be no affect to water temperature at the reach scale from the proposed project and so no mechanism for cumulative effects to water temperature.

Road construction and previous timber sale activities on Forest Service lands and former private lands that are now FS lands removed shade-producing vegetation along portions of perennial streams. The last timber sales within what are now RHCAs occurred nearly 25 years ago. The Pedro-Colt Timber Sale ended in 2007 and there were no vegetation treatments within RHCAs. The Plentybob Timber Sale ended in 2010 and there were no vegetation treatments in RHCAs. Occasional hazard trees are felled along roads within RHCAs and this activity has a negligible effect to shade. Dispersed camping occurs along Phillip Creek at 3 sites and this activity has a localized effect on vegetation. One large dispersed area near the mouth of East Phillips Creek was obliterated in 2013. Approximately 30 miles of roads have been decommissioned in the three subwatersheds during the past 20 years, including roads up Spring Creek and upper Dry Creek. Many of these roads are effectively closed to motor vehicles and are slowly being overtaken by alder. The combined effect of these activities has had a positive effect to shade-producing vegetation in RHCAs. About 12 miles of decommissioned roads are open to ATV use although some of these routes do not receive much, if any use. All alternatives would temporarily open roads for log haul in RHCAs with perennial streams. These activities would not remove any overstory shade-producing trees, although understory hardwoods, such as alder would be cut.

Sedimentation

Past actions including grazing, fires, fire exclusion, harvest, road construction, road obliteration and recreation have occurred in the project area. Plant species composition has changed and invasive plant species are present. Ground cover has been affected and the sediment regime has likely changed some unquantified amount through time, including ongoing actions. No cumulative sediment effects are expected because design criteria and BMPs shape the actions proposed in this project such that no measurable sediment is expected to reach surface waters. See also the Soils Report.

Effects to water quality are directly linked to water yield because, if erosion from a road or hillslope treatment does not enter into a waterbody, there would be no effect to water quality. Sediment transport would occur primarily during spring runoff. Sediments are a major nonpoint-source pollution problem in forests, most often associated with forest roads (MacDonald and Stednick 2003). Erosion resulting from prescribed burning is generally less than that resulting from roads, skid trails, and site preparation techniques that cause soil disturbance (Robichaud et al 2010). Robichaud et al (2010) also reported that sediment effects from fuel management activities generally return to pre-disturbance levels within 1 to 2 years. Direct and indirect effects to soil and watershed resources under proposed action would include short-term (hours to days) impacts such as erosion and sediment delivery resulting from removal of ground cover during construction of temporary roads and landings.

The High Ridge study showed a small increase in peak discharge in two of three harvested watersheds, but the magnitude of the annual snowmelt peak did not change significantly. Helvey and Fowler (1995) concluded that increases in sediment after timber harvest was due more to soil disturbing activities near streams rather than to increased erosive power of the stream.

To reduce sediment potential and help restore infiltration capacity, the temporary roads will be decommissioned as soon as feasible after use. Decommissioning may include blocking, ripping/scarifying, seeding, and possible mulching with emphasis to improve hydrologic soil function. BMP monitoring of decommissioned temporary roads is important to assure hydrologic recovery is occurring and any resultant erosion is reduced to background levels. The Forest Service policy for control of nonpoint sources of pollution is to use BMPs, monitor the implementation and effectiveness of those BMPs, and adjust management practices using monitoring results. The Upper Grande Ronde

TMDL, for example, noted that load allocations for temperature, pH, dissolved oxygen, coupled with ongoing efforts by the U.S. Forest Service to reduce loads from roads and other sources would be adequate to address sedimentation and turbidity concerns for the UGR Subbasin.

Biological Criteria

Changes to aquatic macroinvertebrate communities as a result of cumulative effects from all action alternatives would not occur because there would be direct or indirect effects.

Total Maximum Daily Load

The proposed action is consistent with the Upper Grande Ronde and Umatilla Subbasin TMDL Water Quality Management Plans, which identified the Willow/Phillips Watershed as a high priority area where action is needed to improve water quality for temperature, sediment and flow. PACFISH goals and RMOs are in alignment with the high priorities summarized in Table 54. As stated previously, implementation of alternative B would have positive effects at the habitat scale.

Table 54. Upper Grande Ronde and Umatilla Subbasin WQMP High Priority Management Categories

High Priority Category	Benefit from Action Alternatives
Riparian Vegetation	
- Use active restoration, plant and manage	Yes
- Improve conditions over time, move toward site capability	Yes
- Include management, improvement or removal of problem roads	N/A
- Manage or remove any existing disturbances	N/A
Stream channel/Morphology Improvement	
- Improve width/depth ratios	Yes
- Increase channel stability	Yes
Upland Vegetation Improvements	
- Forest stand structure improvements[1]	Yes

[1]this is a medium priority in the Umatilla Subbasin WQMP

Water Yield

Measure: equivalent treatment area (ETA)

Past harvest within the analysis area had the potential to affect water yield and peakflow, but harvested areas have regrown and currently there is no measureable effect to these parameters. Proposed actions will lead to conifer mortality and created openings as described in the proposed action and Vegetation Report, however the small scale of the mortality and created openings will not affect either water yield or peakflows and so there is no mechanism to create cumulative effects.

The silvicultural treatments proposed in the Thomas Creek Project are not designed to increase stream flow. The proposed action would commercially and non-commercially treat about 4% of the Dry Creek subwatershed, 5% of the Phillips Creek subwatershed, and 6% of the Thomas Creek subwatershed.

The effect of road surfaces, proposed harvest, activity fuel treatment, and prescribed fuel reduction, together with past harvest on water yield and the timing of flows is analyzed using the Umatilla NF

Equivalent Clearcut Acre (ECA) methodology (Ager and Clifton 2005). An equivalent treatment acre (ETA) computer program was developed to simplify use of the model. The NRIS database was used to determine past acres harvested, harvest prescriptions, and year of harvest through 2015 and these values were entered into the model.

Risk to watersheds from changes in cover and evapotranspiration were assigned by McCammon (1993; Table 55).

Table 55: Watershed risk threshold as % ETA

Risk to HUC6	ETA Threshold
Low	< 15%
Moderate	15 – 30%
High	> 30%

Calculated ETAs represent acres of roads, harvest and fire within a subwatershed (Table 33). The model predicts that all action alternatives would cause increases in ETA, however, all values are in the low risk category. Therefore, there is a very low risk that any of the treatments would cause measurable changes in water yield or timing of flows. In addition, ETA decreases over time, as a result of natural and planted revegetation growth. In any given year, the actual effect would be even lower because treatments would occur during the course of several years rather than all at once.

Based on ETA modelling results, literature review of the effects of timber harvest, field reconnaissance of Class I, III and IV streams within the project area and implementation of design features, statistically significant changes to water yield and peak flow would not occur from implementation of any of the action alternatives. In addition, project implementation would occur during the course of years, thus the phasing of activities and asynchronous timing of treatments would further moderate hydrologic effects from thinning and road maintenance.

The relationship between created openings in forested landscapes and changes in water yield and peak flows has been documented by numerous studies. Changes in these parameters would be of concern for aquatic habitat and biota, downstream water users, and for channel morphology.

Grant et al (2008) reported that changes to peak flows < 10% for western Oregon and Washington streams are not detectable. He also found that, for west-side streams, peak flow effects on channel morphology are not likely to occur on streams > 10% gradient and would be minor on step-pool systems (4-10% gradient). Low gradient (< 2%) streams with gravel or smaller-sized bed and bank materials would most likely be at risk of channel adjustments as a result of peak flow increases. They suggest that increased peakflows could occur at ≥ 20% ECA and that the potential for effects to channel morphology is in the 5-10 year recurrence interval flow ranges.

In studies of vegetation manipulation to increase water yield, a large percentage of the basal area must be removed to realize an increase in water yield. The increases in annual water yield following forest harvest are usually assumed to be proportional to the amount of forest cover removed, but at least 15-20% of the trees must be removed to produce a statistically detectable effect (Stednick 1996, Robichaud et al 2010). Other studies have generally noted that 20 to 30 % of a watershed must be harvested before a significant change in streamflow can be detected (Troendle 1983). Robichaud et al (2010) reported that no measurable increase in runoff can be expected from thinning operations that remove less than 15 percent of the forest cover and that any increase in runoff due to thinning operations is likely to persist for no more than 5 to 10 years because evapotranspiration rapidly recovers with vegetative regrowth in partially thinned areas.

Results from the High Ridge Barometer Watershed Study, in the upper Umatilla watershed showed no measurable changes in streamflow until 50% of catchments were in a cutover condition (Helvey and Fowler 1995). The High Ridge watershed is between 4700 to 5300 ft elevation, which is above the rain-on-snow zone (3000-4000 ft). A portion of the Thomas Creek analysis area falls within the rain-on-snow zone. For the transient snow zone of western Washington and Oregon, Grant et al (2008) showed that changes to peak flows were not detectable when < 20% of the basin was harvested.

An additional source of error occurs when measuring streamflow. USGS streamflow data are typically accurate to within 10% of actual flows, but can be far less accurate when measured indirectly, such as from high water marks (Hirsch and Costa 2004) or when measured in less than ideal conditions.

Landscape burning: Table 33 reflects the ETA due to roads, harvest and landscape fire. Approximately 1/3 of the burn area is non-forested grassland and rock faces. In areas that have never been burned, mortality of over-story trees could be as much as 20%. In all other areas less than 10% over story mortality is expected. These assumptions overestimate the reduction in forested cover and are well below levels of concern previously discussed. No openings greater than ½ acre would be created. Risks from rain-on-snow precipitation events would not increase due to this prescribed burn. The affects to water yield would be undetectable because the proposed reduction in live trees is very small relative to drainage area of the Phillips Creek and Thomas Creek subwatersheds.

Modeled effects to water yield and streamflow from Alternative B would result in an increase in ETA as shown in Table 33, but ETA would remain well below the threshold for potential effects to water yield and peak flows.

Under Alternative C, the learning design would add a 100 foot edge zone around the perimeter of 12 units and eliminate 3 units, resulting in a net gain of 74 treatment acres, compared to Alternative B. This would result in a small increase in ETA in the Dry Creek and Thomas Creek subwatersheds (see Table 33) and ETA would remain well below the threshold for potential effects to water yield and peak flows.

Modeled effects to water yield and streamflow from Alternative D would result in an increase in ETA as shown in Table 33 but ETA would remain well below the threshold for potential effects to water yield and peak flows.

Modeled effects to water yield and streamflow from Alternative E would result in an increase in ETA as shown in Table 33, but ETA would remain well below the threshold for potential effects to water yield and peak flows.

RHCA Condition

Channel Morphology

Channel stability is the ability of a stream, over time, in the present climate, to transport the sediment and flows produced by its watershed in such a manner that the stream maintains its dimension, pattern and profile without either aggrading nor degrading (i.e. there is no net change to the dimension, pattern and profile; Rosgen 1996). Natural processes of floods and high severity wildland fire would occur, over time and the surrounding forest would continue to grow and trees would die and some would fall into streams. The result of these phenomena would result in changes to the stream shape and sediment dynamics.

The Thomas Creek Project would not change the flow regime (water yield or peak flows) or sediment regime, therefore there would be no cumulative effect to channel morphology from proposed silvicultural activities. The addition of large wood to Phillips Creek would have a local effect. The upper 5 miles of Phillips Creek, outside of clearcut units, has active recruitment of large wood and this alternative would enhance the ability of this stream segment to dissipate flood flows, detain sediment, build floodplain and improve fish habitat. The lower 3 miles of Phillips Creek is depauperate of both in-stream large wood and potential recruitment of large wood and this project would not change that because there are no treatments proposed along this reach.

Riparian Soil Condition

Cumulative effects to riparian soils would be not occur because changes to road densities and stream crossings at the subwatershed scale of analysis are negligible and implementation of design features would not increase DSC above threshold amounts.

Floodplain Function

Floodplain function is linked to channel morphology and riparian soil condition, and cumulative effects would be as described above.

Wetlands and Groundwater Dependent Ecosystems

Measure: acres of detrimental soil condition in RHCAs

Ground disturbing activities would not occur in stream- or spring-associated wetlands, therefore, there would be no direct or indirect effects to wetlands as a result of this alternative. Spring, seep and other wetland areas not previously identified and which are identified during unit layout would also be protected with no-skid buffers.

Regulatory Framework

Land and Resource Management Plan

The Umatilla National Forest Land and Resource Management Plan (LRMP) provides standards and guidelines as shown on pages 30-34.

Compliance with LRMP and Other Relevant Laws, Regulations, Policies and Plans

Clean Water Act of 1972

The Clean Water Act of 1972 and amendments require the restoration and maintenance of the chemical, physical, and biological integrity of the nation's waters. All of the activities proposed in this project were designed to be consistent with the Clean Water Act and State of Oregon Water Quality Standards and Total Maximum Daily Loads.

Floodplains, Executive Order 11988

E.O. 11988 requires the Forest Service to avoid "to the extent possible the long and short term adverse impacts associated with the ... occupation ... or modification of floodplains..." The E.O. also provides direction to restore and preserve the natural and beneficial values served by floodplains. Actions proposed in the Thomas Creek Project would preserve the beneficial values of floodplains within the project area and for this reason, the Thomas Creek Project is consistent with this EO.

Wetlands, Executive Order 11990

E.O. 11990 requires the Forest Service to "avoid to the extent possible the long and short term adverse impacts associated with the ... destruction or modification of wetlands." The Thomas Creek Project does not propose to destroy or modify any wetland. For this reason, the Thomas Creek Project is consistent with this EO.

Municipal Watersheds

There are no designated municipal watersheds in the Thomas Creek Project area.

Safe Drinking Water Act

There are no Source Water Areas in the Thomas Creek Project area.

Summary of Environmental Effects

Table 56: Summary comparison of environmental effects to water quality and water quantity

Resource Element	Measure	Alt A	Alt B	Alt C	Alt D	Alt E
Water Quality	Temperature (canopy density)	No change to canopy density and therefore no change to stream temperature.	No change to canopy density in primary shade zone and therefore no change to stream temperature at reach scale.	Same as Alt B	Same as Alt B	Same as Alt B
	Shade (canopy density)	No change to canopy density and therefore no change to stream shading.	No change to canopy density in primary shade zone and therefore no change to stream shading at reach scale.	Same as Alt B	Same as Alt B	Same as Alt B
	Sedimentation (road density, stream crossings)	No change to road density or number of stream crossings, therefore no change to sedimentation.	Increase of 1.0 mile of temporary roads and addition of 1 temporary intermittent stream crossing. Temporary increase in traffic on 45.8 miles of haul roads. Haul roads improved/ maintained to standard and design features implemented to minimize sediment. Changes to sediment regime at subwatershed scale not detectable.	Increase of 0.75 miles of temporary roads and addition of 1 temporary intermittent stream crossing. Temporary increase in traffic on 44.6 miles of haul roads. Haul roads improved/ maintained to standard and design features implemented to minimize sediment. Changes to sediment regime at subwatershed scale not detectable.	Temporary increase in traffic on 39.6 miles of haul roads. Haul roads improved/ maintained to standard and design features implemented to minimize sediment. Changes to sediment regime at subwatershed scale not detectable.	Increase of 1.0 mile of temporary roads and addition of 1 temporary intermittent stream crossing. Temporary increase in traffic on 54.3 miles of haul roads. Haul roads improved/ maintained to standard and design features implemented to minimize sediment. Changes to sediment regime at subwatershed scale not detectable.
	Biological Criteria (macroinvert-ebrates)	No change to amount, timing, or duration of stream flow, or sediment dynamics, therefore no change to macroinvertebrate communities.	Same as Alt A	Same as Alt A	Same as Alt A	Same as Alt A

Water Yield	Road density, stream crossings, ETA	No change to road density or number of stream crossings. No change to % ETA, therefore, no change to water yield.	Increase of 1.0 mile of temporary roads and 1 temporary intermittent stream crossing results in negligible change at subwatershed scale. Increase of ETA from 2.2% to 7.4 %, which is below 15% threshold. Changes to water yield at subwatershed scale not detectable.	Increase of 0.75 mile of temporary roads and 1 temporary intermittent stream crossing results in negligible change at subwatershed scale. Increase of ETA from 2.2% to 7.6 %, which is below 15% threshold. Changes to water yield at subwatershed scale not detectable.	Increase of ETA from 2.2% to 7.1 %, which is below 15% threshold. Changes to water yield at subwatershed scale not detectable.	Increase of 1.0 mile of temporary roads and 1 temporary intermittent stream crossing results in negligible change at subwatershed scale. Increase of ETA from 2.2% to 8.4 %, which is below 15% threshold. Changes to water yield at subwatershed scale not detectable.

Table 57: Summary comparison of environmental effects to riparian-wetland areas

Resource Element	Measure	Alt A	Alt B	Alt C	Alt D	Alt E
RHCA Condition	Channel morphology (w/d, substrate, pools, large wood)	No change to channel morphology.	Addition of large wood improves morphology at habitat scale. No change to morphology at watershed scale.	Same as Alt B	Same as Alt B	Same as Alt B
	Riparian soil condition (roads in RHCAs, number of stream crossings, DSC)	No change to roads in RHCAs, no change to number of stream crossings, therefore, no change to riparian soil condition.	15 miles of haul routes in RHCAs with change from low to high use during log haul. Increase in 1 temporary intermittent stream crossing. DSC negligible. Design features implemented to minimize sediment.	14.9 miles of haul routes in RHCAs with change from low to high use during log haul. Increase in 1 temporary intermittent stream crossing. DSC negligible. Design features implemented to minimize sediment.	13.9 miles of haul routes in RHCAs with change from low to high use during log haul. DSC negligible. Design features implemented to minimize sediment.	15.9 miles of haul routes in RHCAs with change from low to high use during log haul. Increase in 1 temporary intermittent stream crossing. DSC negligible. Design features implemented to minimize sediment.
	Floodplain function (roads in RHCAs, number of stream crossings, large wood)	No change to road density or number of stream crossings, or large wood, therefore no change to floodplain function.	See Channel morphology See Riparian soil condition	See Channel morphology See Riparian soil condition	See Channel morphology See Riparian soil condition	See Channel morphology See Riparian soil condition
Wetlands	Wetland function (DSC)	No change to soil condition in or near wetlands, therefore no change to wetlands.	Same as Alt A	Same as Alt A	Same as Alt A	Same as Alt A

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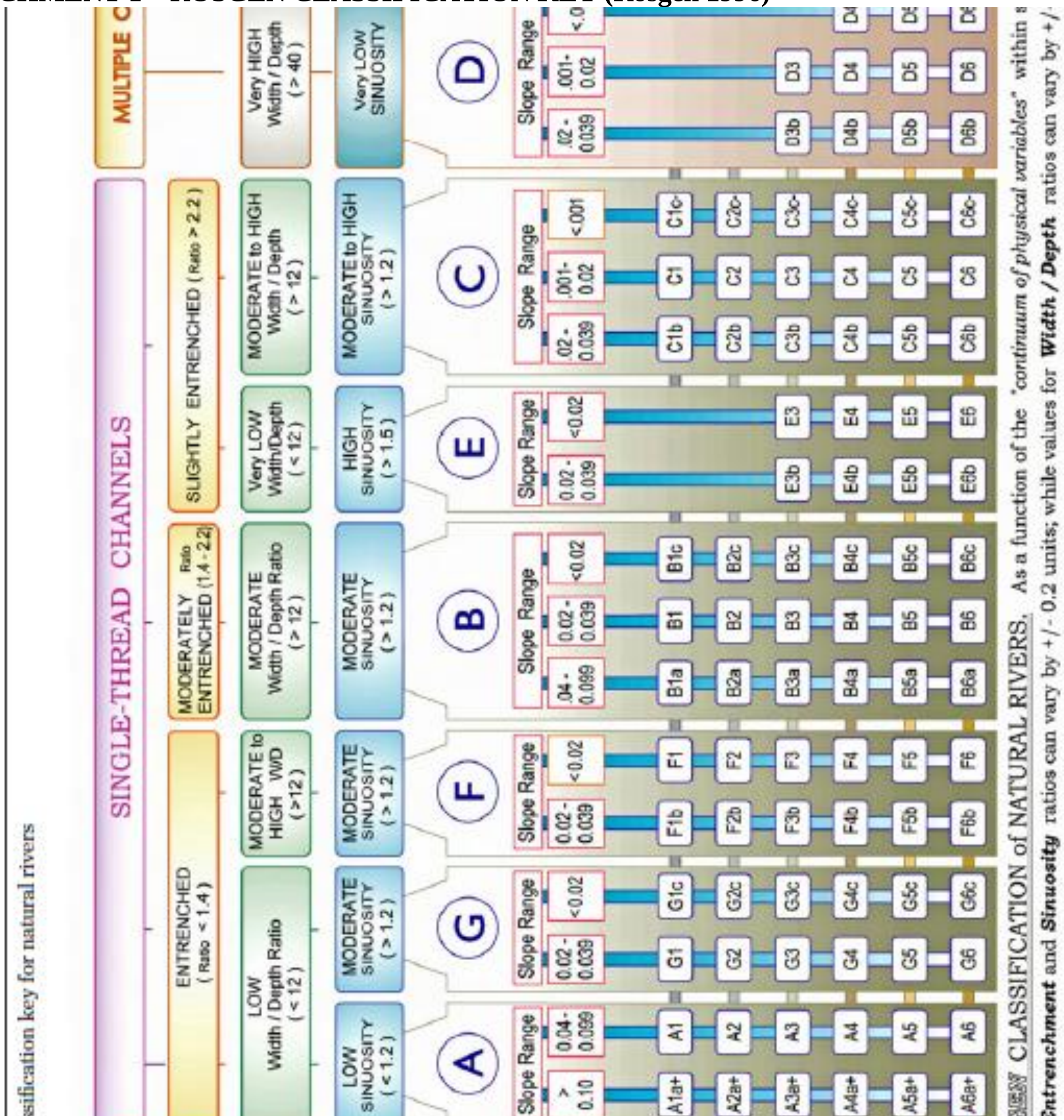
ATTACHMENT 1 – ROSGEN CLASSIFICATION KEY (Rosgen 1996)



Valley types used in the geomorphic characterization and their associated stream types (Rosgen, 1996, 2006)

Valley Type	Summary Description of Valley Types	Stream Types*,**
I	**Steep, V-Notched Drainageways:** Steep, confined, V-notched valleys with rejuvenated side-slopes	**Aa+**, **A**, **G**
II	**Colluvial:** Moderately steep valley slopes with gentle to moderate side slopes associated with colluvial deposition of residual soils	**B**, [F], [G]
III	**Alluvial Fans:** Primarily depositional with characteristic alluvial fan landforms with two subtypes: (a) *Active alluvial fan:* Actively building fan surface with high sediment supply storage (b) *Inactive alluvial fan:* Non-building, stable fan with low sediment supply and generally well-established riparian vegetation	**D**, [A], [F_b], [G] **B**, [F_b], [G]
IV	**Inter-Gorge:** Canyons, gorges & confined alluvial valleys with gentle valley-floor slopes, steep valley walls, and meandering, entrenched channels	**C**, **F**, B_c
V	**Glacial Trough:** Moderately steep, U-shaped glacial-trough valleys	**C**, **D**, B_c, [F], [G]
VI	**Bedrock:** Bedrock-controlled valleys with gentle to moderately steep valley slopes	**Aa+**, **A**, **B**, **C**, **F**, **G**
VII	**Fluvial-Dissected:** Steep, fluvial-dissected, high-drainage density, alluvial landscapes	**Aa+**, **A**, **G**, B, F_b
VIII	**Alluvial:** Alluvial valley fills with well-developed floodplains: (a) *Gulch Fill:* Narrow valley widths (< 4 channels widths), relatively steep valley side slopes, and valley-floor slopes greater than 0.5% (b) *Alluvial fill:* Moderate valley widths (4 to 10 channel widths) and moderately steep valley side slopes and valley-floor slopes less than 4% (c) *Terraced Alluvial:* Wide valley widths (> 10 channel widths) and gentle valley-floor slopes less than 2% with river or glacial terraces	**B**, **$C_{(b)}$**, **E_b**, [A], [D], [F_b], [G] **B**, **$C_{(b)}$**, **$E_{(b)}$**, [A], [D], [F_b], [G] **C**, **E**, B_c, [A], [D], [F], [G_c]
IX	**Glacial Outwash:** Broad, gentle valley slopes associated with glacial outwash	**C**, **D**, B, [F], [G],
X	**Lacustrine:** Very broad and gentle valley slopes associated with glacio- and nonglacio-lacustrine deposits	**C**, **DA**, **E**, B_c, [F], [G_c]
XI	**Deltas:** Large river deltas & tidal flats constructed of fine alluvial materials from riverine and estuarine depositional processes; most often distributary channels, wave- or tide-dominated	**D**, **DA**, C, E
XII	**Eolian:** Broad, undulating valley terrain with gentle valley slopes associated with materials deposited by wind and reworked by fluvial processes (a) *Eolian Sand* 1. Sand Dunes 2. Abandoned Beach Sand, Shorline (Littoral) Drift, Foredunes, and Periglacial Sand Splays 3. Sand Hills (b) *Eolian Loess:* Associated with silt-sized material from glacial and non-glacial processes, including ash deposits from volcanism	**C**, **D**, [F], [G] **B**, [A], [F], [G] **B**, A, [F], [G] **B**, **C_b**, **E_b**, [A], [F_b], [G]

*Bolded stream types indicate the most prevalent stream type for that valley type

**Bracketed stream types are most often observed under disequilibrium conditions

ATTACHMENT 2 – POOL-TO-POOL CENTRAL TENDENCY

Central Tendency Pool to Pool Spacing Summary (Rosgen: pages 6-25, 6-26)

Morphology	**Stream Type**	**Slope**	**Bankfull Widths**
Riffle-Pool	C, E	< 2%	5 - 7
Riffle-Pool (entrenched)	F	< 2%	4 - 5
Step-Pool Rapids	G B	2 - 4%	3 - 4
Step-Pool	A	4 – 6%	2 - 3
Cascade	Aa+	> 6%	1.5 - 2
The **spacing** of channel step features is *proportional to stream width*, and *inversely related to channel slope*			
Response to LWD:	- LWD changes slope, affects potential and kinetic energy, shifts boundary shear stress, creates extremes of velocity, and directly influences sediment storage - Many A, B, and G step/pool streams have evolved with LWD - The stability and biological function of A, B, and G streams is directly linked to the type, amount and extent of large, woody debris. - A, B, G generally respond to **reduced** woody debris input by an **increase** in channel scour and **increases** the spacing of step/pool features, as a function of BFW and slope - An <u>increase in step-pool spacing</u> reduces the characteristic mode of natural energy dissipation for A, B, and G streams and frequently corresponds to a **reduction** in fish habitat. - Stream type A1, A2, B1-B6 can support a considerable amount of organic debris and flow blockages **without** developing adverse impacts. **- Riffle-pool stream types such as C3-C6, E3-E6, and D3-D6 can be adversely affected by excessive or poorly placed LWD** - Exceptions to the average bed feature sequence spacing as a function of gradient and width are found where inputs of large woody debris to the system influence the natural sequence of rock-material bed features.		

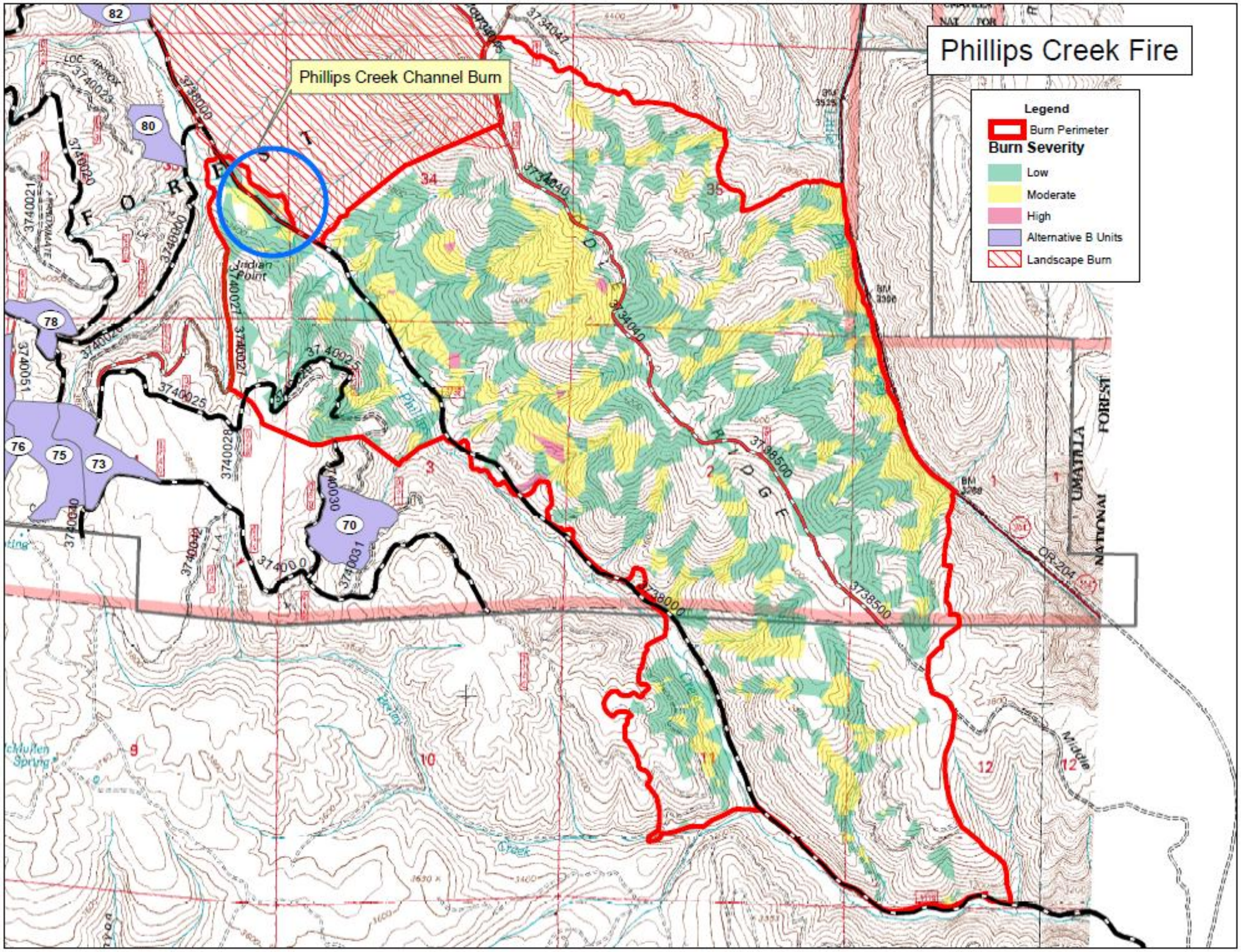
ATTACHMENT 3 – WATER SOURCES AND DEVELOPMENTS

Water Source	X	Y	Name	Development	Comment
Spring	411607.8	5048855.3	Spring Creek Dev. Pond	earthen tank	slope spring dug out to make a stock tank (Spring Ck dev. pond); berm and outlet stable
spring fed; runoff	413020.7	5050349.5	Dry Creek 3 Pond	earthen tank	spring fed tank east of FR3200140; no flow or riparian below tank; berm and outlet stable; mostly filled with sediment
Spring	412928.3	5050400.2			in-channel; flows ~ 400 feet down to Dry Creek 3 pond
Spring	412922.3	5050417.8			in-channel; flows about 75 ft into next draw then down to Dry Creek 3 Pond
unknown	413521.6	5050872.9	Dry Creek Pond	earthen tank	no data
unknown	414985.8	5050818.9	Little Bit Pond	earthen tank	no data
Spring	414647.1	5051329.9	Tree Stand Pond	earthen tank	hillslope spring dug out to make Tree Stand Pond; heavy wildlife use; berm stable; high amount of bare ground; salt lick and game camera; LEO removed old metal tree stand
Seeps	412251.1	5053144.2			in-channel; seepy area about 200 ft long; heavy sheep use
Spring	412268.2	5053238.8			hillslope; flows ~ 100 ft; heavy sheep use
Well	411677.1	5053296.7	Ruckel Spring	concrete vault	Ruckel Spring; concrete vault 4 ft diameter; no surface flow or riparian area; water level below ground surface
spring	412181.8	5053326.3			hillslope; flows ~ 100 ft; heavy sheep use
Seep	412107.5	5053562.1			in-channel seep
Seep	412063.5	5053605.1			in channel; small seep
spring	413085.4	5054705.8			hillslope spring; old pvc pipe; flows thru cmp under FR3200120 into Dry Ck
unknown	417331.4	5049257.4	Phillips 5 Pond	earthen tank	no data
wetland	416494.9	5049296.7	Phillips 3 Pond	earthen tank	valley bottom; tank excavated into wetland; berm stable; FR3740040 also runs thru wetland; cow use
wetland	416519.9	5049628.3	Christenson Pond	earthen tank	valley bottom; tank excavated into wetland; berm and outlet stable; cow use
unknown	417353.9	5049663.1	Phillips 4 Pond	earthen tank	no data
spring	416476.1	5049795.6		earthen tank	off-channel spring; tank excavated at spring; berm and outlet stable; cow use
runoff	416428.2	5049896.8	Phillips 2 Pond	earthen tank	earthen tank in draw bottom; non-riparian; berm and outlet stable
unknown	416581.5	5050775.9	Phillips 1 Pond	earthen tank	no data
runoff	414707.9	5054833.4		earthen tank	shallow depression; runoff from 3148040
runoff	414100.6	5055036.2	Six Story #1 Pond	earthen tank	berm and outlet stable
wetland	415223.0	5055817.5			off-channel wetland; flows to Phillips Creek
seep	414402.1	5056939.8			roadcut seep along FR3738090
spring	414193.0	5057094.6			hillslope spring just above old logging road; flows onto road then into Portuguese Draw

unknown	416077.8	5057055.9	East Phillips 5 Pond	earthen tank	no data
spring	414070.4	5057155.2			off-channel toeslope spring just above old logging road
spring	414242.3	5057224.4	Portuguese Spring	metal trough	not field verified
spring	411548.0	5051449.2			in-channel; flows about 150 ft into Murchison 3 pond, no gps
spring fed; runoff	411542.4	5051508.1	Murchison 3 Pond	earthen tank	spring fed stock tank (Murchison 3 pond); berm and outlet stable
wetland	411485.6	5051934.7			remnant wetland area; floodplain adjacent channel; terminus of headcutting, several off-channel springs
unknown	411069.9	5052703.8	Murchison 2 Pond	earthen tank	no data
spring	410795.2	5053266.5			in-channel spring, flows down to confluence; location approximate
seep	411076.2	5053402.9			in-channel; small seepy area just east of FR3145000
runoff	411476.1	5053396.4	Pit Ruckel Road	earthen tank	old rock pit?
runoff	411599.0	5053424.5		earthen tank	small excavation at Ruckel Junction
unknown	411141.2	5053817.7	Murchison 1 Pond	earthen tank	no data
seep	411738.7	5054345.3			seep on FR3100229
unknown	411635.0	5055171.9	Thomas Creek #4 Pond	earthen tank	no data
spring	413114.7	5056582.7			in-channel; flows ~ 250 to Thomas Creek #5 Pond at FR3100239; no flow below road crossing
spring fed; runoff	413038.8	5056605.5	Thomas Creek #5 Pond	earthen tank	earthen tank dug out at FR3100239; mostly full of sediment; cmp outlet mostly buried; overflow over road is stable
spring	413291.6	5057071.6			in-channel
spring	412813.1	5057446.8			in-channel

NAD 83 ZONE 11 NORTH

ATTACHMENT 4 – PHILLIPS CREEK FIRE



ATTACHMENT 5 – PROJECT DESIGN FEATURES

Item	Design Feature	Timber Sale Contract	Forest Plan	PACFISH	BMP- National Core Technical Guide (2012)
Aquatic Management Zones Activities Objective: To maintain and improve or restore the condition of land around and adjacent o waterbodies in the context of the environment in which they are located.					
1	Proactively manage the AMZ to maintain or improve long-term health and sustainability of the riparian ecosystem and adjacent waterbody with desired conditions, goals and objectives in the land management plan.	Yes	4-59 4-164	TM-1b, C-10 FM-4, C-16 FW-1, C18	Plan-3 Veg-3
2	Determine the width of the AMZ for waterbodies in the project area that may be affected by the proposed activities. Stream and RHCA protection are based on the Forest Plan as amended by PACFISH. Default PACFISH RHCA widths are: ***Fish Bearing Stream (PACFISH Category 1, R6 Stream Class I, II)*** ***300 ft*** ***Perennial Non-Fish Bearing Stream (Category 2, Class III)*** ***150 ft*** ***Ponds, Lakes, Reservoirs and Wetlands > 1 ac (Category 3)*** ***150 ft*** ***Intermittent Streams, wetlands < 1ac, landslide prone areas*** ***100 ft*** Tables 1-4 below identify limits for ground-based activities in RHCAs.	Yes	E-29	C-8	Plan-3 Veg-1 Veg-3
3	Specify RHCA layout, maintenance, and operating requirements in contracts, design plans and other necessary project documentation.	Yes	4-77		Plan-3 Veg-3
4	Use mechanical vegetation treatments in the RHCAs only when suitable to achieve long-term desired conditions and management objectives.	N/A	4-59, 4-60, 4-77, 4-164, 4-165	TM-1b, C-10	Plan-3 Veg-3, Veg-4
5	Modify mechanical vegetation treatment prescription and operations in the RHCAs as needed to maintain ecosystem structure, function and process.	N/A	4-77, 4-164, 4-165	FW-1, C-18	Plan-3 Veg-3
Mechanical Vegetation Management Activities Objective: Avoid, minimize, or mitigate adverse effects to soil, water quality, and riparian resources that my result from mechanical vegetation treatment activities. Includes measures for protection of Riparian Habitat Management Areas (RHCA's), minimization measures for ground-based skidding and yarding operations, erosion prevention and control measures, and mitigations for winter harvest and mechanical site treatment.					
General					
6	Harvest unit design should ensure favorable conditions of water flow, water quality and fish habitat.	N/A	4-77		Veg-1
7	Prevent downstream water quality degradation by the timely identification of areas with high erosion potential and adjustment of harvest unit design.	Yes	4-59, 4-77		Veg-1
8	Delineate the location of protection areas and available water sources as a guide for both the purchaser and the sale administrator, and to ensure their recognition and proper consideration and protection on the ground.	Yes	4-77	RA-5, C-17	Veg-1
9	Use existing roads, landings, skid trails and other previously disturbed areas where their use is compatible with protecting water, riparian and soil resources. Sale administrator would work	Yes	4-77		Veg-1 Veg-4

Item	Design Feature	Timber Sale Contract	Forest Plan	PACFISH	BMP- National Core Technical Guide (2012)
	with contractor to locate these areas on the ground wherever possible.				Veg-6
10	Equipment staging, parking and refueling will be outside of RHCAs and in areas designated by the sale administrator that have previous soil disturbance. This includes prescribed fire activities.	Yes	4-77	RA-4, C-17	AqEco-2 Veg-2, Road-10
11	Locate transportation facilities for mechanical vegetation treatments, including roads, landings and main skid trails, outside of the RHCA to the extent practicable.	Yes	4-77	RF-2b, C-10	Veg-2, Veg-3, Veg-5
12	Vehicular or skidding equipment shall not be used on meadows or lithosols (scab flats) except where roads, landings, and tractor roads are pre-approved.	Yes	4-80		Veg-1
13	Maintain the natural drainage pattern of the area wherever practical, apply soil protective cover (such as mulch or slash) on disturbed areas.	Yes	4-77 4-80	RF-3, C-11	Road-2, Veg-2, Veg 4, Veg-6
Skidding/Yarding					
14	Utilize yarding mechanisms or mechanical treatments that avoid or minimize disturbance to the ground and vegetation consistent with project objectives.	Yes	4-77		Plan-3, Veg-1, Veg-3
15	Design and locate skid trails and skidding operations to minimize soil disturbance to the extent practicable.	Yes	4-60, 4-77	RF-2b, C-10	Veg-3, Veg-4, Veg-6
16	No ground-based equipment will operate on sustained slopes greater than 35% in order to reduce the potential for soil movement.	Yes	4-77 4-80 E-28		Veg-2 Veg-4
17	All logging systems will provide at least one-end suspension.	Yes	4-80		Veg-2
18	Avoid ground equipment operations on unstable, wet or easily compacted soils and steep slopes.	Yes	4-77, 4-80		Veg-1 Veg 2
19	Yarding will be spaced for optimum efficiency and minimum soil disturbance. Forwarder trails will average 50 feet apart, except where converging. Conventional system trail spacing will average 100 feet. Skyline system corridors will average 150 feet apart. All trails will be approved prior to use.	Yes	4-80		Veg-4
20	Use of ground based harvest equipment will not be permitted when soils reach field capacity (heightened moisture content), to limit the potential of long-term detrimental soil conditions, as described in the Forest Plan, or if ruts greater than 2-4 inches occur. Log haul will only be permitted on dry or frozen roads.	Yes	4-77 4-80	RF-2b, C-10 RF-3, C-11	Veg-2 Veg-4
21	Directionally fell trees to facilitate efficient removal along pre-designated yarding patterns with the least number of passes and least amount of disturbed area.	Yes	4-77 4-80		Veg-4
23	Required skid trails will be reviewed by a soils specialist to the extent practicable.	Yes	4-77, 4-80		Veg-3
24	Ephemeral draws and stream channels will not be used as forwarder trails, landing sites, slash or fuels pile locations, or as road locations. Skidding up and down ephemeral draws/swales will be prohibited.		4-80		Veg-4
25	Logging systems will be designed to minimize crossing ephemeral draws. • Ground based equipment will only cross ephemeral draws (swales) and channels at	Yes	4-77 4-80	RF-2b, C-10 RF-3, C-11	Veg-3, Veg-4, Veg-6

Item	Design Feature	Timber Sale Contract	Forest Plan	PACFISH	BMP- National Core Technical Guide (2012)
	sites pre-approved by the responsible Forest official, and crossings will be minimized. • Ephemeral draws will not be crossed where equipment will cause bank breakdown. • There will be minimum 100 foot spacing between designated stream crossings. • Mechanical fuels treatments will use existing trails created by logging operations when crossing ephemeral draws and channels • If crossing swales during runoff is anticipated, culverts, bridges, and/or rock/earth work will be used to stabilize and armor channel banks and bottoms and prevent erosion. • Debris may be placed into the crossings to reduce soil disturbance, compaction, and erosion. However, the debris must be removed before the unit is closed out. • Trees within these swales may be cut and dragged or lifted out. • In ephemeral draws, 25 feet each side of the channel centerline, retain all wood embedded in the soil and maintain a number of down woody debris pieces equal to or exceeding the number and size of pieces specified for snag retention below.				
26	Within commercial harvest units, no harvest or heavy equipment will leave designated roads or trails, to limit the potential of detrimental soil disturbance. The exception to equipment leaving designated trails will be specific to harvester/forwarder operations. In the event that harvester/forwarder is used, they will be required to have no less than 1 foot of slash (depth) under both equipment tracks. This slash load should buffer the weight of equipment when operating on other than designated trails.	Yes	4-80	RF-2b, C-10	Veg-2
27	In non-commercial thinning units, mechanical thinning equipment may be used provided that equipment that exceeds 7 PSI is not allowed to travel over the same path more than once.	Yes	4-80		Veg-3, Veg-8
28	If grapple piling is used for fuels reduction, equipment will be required to travel over $\geq$1 foot of slash, and utilize designated trails. Once the equipment reaches a starting point it will back out of the unit riding on material being piled.	N/A	4-80		Veg-3, Veg-8
Erosion Control					
29	Erosion control and sediment plans will cover all disturbed areas including skid trails and roads, landings, cable corridors, temporary road fills, water source sites, borrow sites or other areas disturbed during mechanical vegetation treatments.	Yes	4-77		Veg-1, Veg 2
30	Install sediment and stormwater controls prior to initiating surface disturbing activities to the extent practicable.	Yes	4-77		Veg-1, Veg 2
31	During and upon completion of harvest activities erosion control measures will occur on forwarder trails and landings.		4-80		Veg-2, Veg-3
32	Install and maintain suitable erosion control on skid trails prior to spring runoff. This may include seeding, mulching, lop and scatter slash, waterbars, scarifying, subsoiling. Reshape the surface to promote dispersed drainage and install suitable drainage features.	Yes	4-77		Veg-2, Veg-3

Item	Design Feature	Timber Sale Contract	Forest Plan	PACFISH	BMP- National Core Technical Guide (2012)
33	Post-activity exposed mineral soil will be treated as necessary to reduce soil erosion and compaction. This may include seeding, installation of waterbars, mulching with native material, or subsoiling. Where possible and needed, skid trails will be subsoiled and/or have logging slash and large wood left.		4-80		Veg-2, Veg-3
34	For maintaining soil productivity the upper limit of the following ranges for coarse woody debris materials should be retained to levels specified below: • 5 to 20 tons per acre for warm dry ponderosa pine and Douglas-fir ecotypes • 10 to 30 tons per acre for cool Douglas-fir ecotypes		4-80		Veg-8 Fire-2
35	Subsoiling is to be implemented in units with post-project levels exceeding 20% of the unit area. Recommendation for the amount and location of subsoiling will be made by the Forest Soil Scientist and will be based on site and soil characteristics.		4-80		Veg-8
RHCA Treatments					
36	Aquatics specialists would monitor the RHCA whenever possible during mechanical operations to evaluate compliance with prescription and mitigation requirements.	N/A	4-77	C-22	Plan-3, Veg-3
37	RHCA mineral soil exposure will be limited to 10% or less. Heavy equipment would not operate within the inner 75 feet of PACFISH buffers (see Table 1 below). Trees to be removed from RHCAs would be directionally felled to allow one end suspension and whole tree yarded.	Yes	4-165		Veg-3, Fire-2
38	Do not cross channels or operate within the inner gorge of channels with heavy equipment	Yes	4-62, 4-80		Veg-3
39	Do not use drainage bottoms as turn-around areas for equipment during mechanical vegetation treatments. Do not cross channels or operate within the inner gorge of channels with heavy equipment.	Yes	4-77	RF-2b, C-10	Veg-3
40	Retain trees as necessary for canopy cover and shading, bank stabilization and as a source of large woody debris within the RHCA. Leave all trees on stream banks. Avoid felling trees into streams or waterbodies, except as planned to create habitat features.	Yes	4-59 4-60 4-77	TM-1b, C-17 FW-1, C-18	Veg-3
41	Retain all trees within the inner gorge area to maintain soil and slope stability. Bank and channel stabilizing trees located on the inner gorge and the valley/channel bottom will remain uncut.	Yes	4-62 4-80		Veg-3
42	Fell trees larger than 6-inch dbh into Class III streams to provide large woody material needed for stream morphology and sediment capture, within the requirements for shade. Trees will be identified by aquatics specialists.	Yes	4-60 4-164		AqEco-4, Veg-3
43	Trees may be felled in RHCAs when they pose a safety risk. If possible, keep felled trees on site to meet woody material objectives. Also, safety risk trees along roads within RHCAs or within 100 feet of stream crossings which are cut must be left on site. When feasible, fall safety risk trees toward streams.	Yes	4-59	RA-2, C-17	Veg-3
44	Use suitable measures to disperse concentrated flows of water from road surface drainage features to avoid or minimize erosion, gully formation and mass failure in the RHCA and sediment transport to the waterbody.	Yes	4-77 4-80	RF-2, C-10	Veg-2, Veg-3, Road-4

Item	Design Feature	Timber Sale Contract	Forest Plan	PACFISH	BMP- National Core Technical Guide (2012)
45	All skid trails, forwarder trails, and landings which are within Riparian Habitat Conservation Areas will be stabilized as necessary to reduce soil erosion and compaction. This may include planting, seeding, protection of plants, earthwork, and cultivation practices. Stabilization work will be done each year in October. Planting, seeding, protection of plants and shallow cultivation (chain harrowing) will generally be done by the Forest Service as funds are available. Any seeding will use native seed provided by the FS. If the FS is unable to provide native seed, non-persistent exotic species may be used if approved by Forest Botanist. Hay and straw used for mulch or erosion control will also be provided by the FS.	Yes	4-60 4-77 4-80	RF-2, C-10 RF-3, C-11	Veg-3, Veg-4, Veg-6, Veg-8
46	Activities would be mitigated by operating in dry or frozen conditions. Outside of these exceptions, heavy equipment will not operate off roads within the RHCAs.	Yes	4-77 4-80 4-165	RF-2, C-10 RF-3, C-11	Veg-3, Veg-4, Veg-7
47	Winter harvest will be considered in areas with sensitive riparian conditions or other potentially significant soil erosion and compaction hazards.	Yes	4-77		Road-4, Veg-7
48	Do not cut, masticate or drive over shrubs, hardwoods, or trees unnecessarily in RHCAs.	Yes	4-164		Plan-3
49	In areas of harvest within the RHCA, no equipment or scour from skyline corridors will be allowed within either 75 or 100 feet of the water; depending upon RHCA slopes. In the WEPP modeling it was determined that these no equipment buffers are needed to limit scour from the repeated activities of ground based or skyline activities. To implement this design feature see Table 1 below for criteria and distances.	Yes	1-60 4-164	TM-1b, C-10 FW-1, C-18	Veg-2 Veg-3 Veg-4
Landings					
50	Landings will be designed to minimize size and constructed to minimize adverse effects and provide for safe operations. Select landing locations for least amount of excavation and erosion potential, where sidecast will neither enter drainages nor damage other sensitive areas.	Yes	4-77 4-80	RF-2b, C-10	Veg-6
51	Locate landings outside of the RHCAs and avoid locating landings on steep slopes or highly erodible soil.	Yes	4-80 4-165	RF-2b, C-10	Veg-6
52	Design roads and trail approaches to minimize overland flow entering the landing.	Yes	4-80	RF-2b, C-10	Veg-6
53	Existing landings will be used where their location is compatible with management objectives.	Yes	4-80	RF-2b, C-10	Veg-6
54	Use suitable measures as needed and/or restore and stabilize the landing after use.	Yes	4-80	RF-2b, C-10	Veg-6
Road Management Activities Objective: Avoid, minimize, or mitigate adverse effects to soil, water quality, and instream riparian resources that may result from road management activities.					
All Haul Roads					

Item	Design Feature	Timber Sale Contract	Forest Plan	PACFISH	BMP- National Core Technical Guide (2012)
55	Ensure the road surface drainage system can intercept, collect and remove water from the road surface and surrounding slopes in a manner that reduces concentrated flow in ditches, culverts and over fill slopes and road surfaces.		4-77	RF-3, C-11	Road-4
56	Ensure road surface treatment will support wheel loads, stabilize the roadbed, reduce dust and control erosion consistent with anticipated traffic and use		4-78	RF-3, C-11	Road-4
57	Road blading would be done only when necessary. Ditches would not be routinely bladed, and exposed soil areas on road prisms, ditches, cuts, and fills would be seeded with plants non-palatable to wildlife if funds are available. To minimize the need for blading, haul roads would not be used when detrimental rutting occurs because of wet weather.	Yes	4-77 4-80	RF-3, C-11	Road-4
58	Ensure culverts do not become plugged from logging activities and thereby do not affect the functionality of the roads.	Yes	4-77	RF-3, C-11	Road-4, Veg-3
59	Rock surfacing will be used on haul routes that cross or otherwise enter RHCAs		4-77 4-78	RF-3, C-11	Road-4
60	During road maintenance side casting of materials will not occur where these materials could be directly or indirectly introduced into a stream, or where the placement of these materials could contribute to the destabilization of the slope.		4-77 4-78	RF-3, C-11	Road-4
61	Waste materials removed during road maintenance activities, including ditch and culvert cleaning, will be deposited in approved disposal areas outside of RHCAs. For erosion control and stabilization the disposal site will be seeded with native seed.		4-77 4-78	RF-3, C-11	Road-4
62	Commercial use of National Forest roads shall be suspended when commercial contract or permit operations create a continuous discharge of sediment into live streams that result in an increase on turbidity. This may be from pumping of saturated fines creating sediment-laden water on and/or from the road surface. Visual evidence of this may be identified by the increase in turbidity in live running streams evident at points downstream from the outflows of culverts, ditch-lines, or fords (Umatilla NF Road Use Rules).		4-77 4-78	RF-3, C-11	Road-4
Temporary Roads – Construction/Reconstruction					
63	New roads should be located outside the riparian area unless alternatives are determined to have higher adverse impacts	Yes	4-77 4-80 4-165	RF-2b, C-10	Road-2
64	Temporary roads will be located to minimize or mitigate adverse effects to soil, water quality and riparian resources. Locate roads to fit the terrain, follow natural contours. Avoid steep grades and unstable soils/terrain.	N/A	4-77 4-80	RF-3, C-11	Road-2 Road-5
65	Use existing routes where practical. Existing routes include Operation and Maintenance Level 1 Roads, Decommissioned Roads and Non System Routes		4-80	RF-3, C-11	Road-1
66	Placement of new temporary roads will be on deep soils, if it is operationally feasible. This will		4-80	RF-3, C-11	Road-1, Road-2

Item	Design Feature	Timber Sale Contract	Forest Plan	PACFISH	BMP- National Core Technical Guide (2012)
	allow for adequate restoration of temporary roads and over time will leave less measurable detrimental soil condition across the proposed activity units				
67	Maintain the natural drainage pattern of the area wherever practical, apply soil protective cover (such as mulch or slash) on disturbed areas.	Yes	4-77 4-80	RF-3, C-11	Road-2, Veg-2, Veg 4, Veg-6
68	Temporary roads will be inspected to verify that erosion and stormwater controls are implemented and functioning and are appropriately maintained.	N/A	4-77 4-80	RF-3, C-11	Road-1, Road-5
69	Provide sufficient buffer distance at the outfalls of road surface drainage structures for water to infiltrate prior to reaching a stream and limit the number and length of water crossing connected areas to the extent practicable		4-80	RF-3, C-11	Road-2
70	FR3145 culvert installation will be correctly sized, bedded in native material and placed on natural stream grades. Installation will occur during dry conditions. Culvert will be removed and streambank stabilized after units are treated.		4-77 4-78	RF-3, C-11	Road-2, Road-3, Road-7
Temporary Roads – Road Storage and Rehabilitation					
71	Obliterate temporary roads as soon as feasible after no longer needed for project activity.		4-85	RF-3c, C-12	Road-6
72	All temporary roads that are used for this project would be obliterated to reduce compaction. These roads will be scarified or subsoiled (where possible depending upon the soil depth and slash will be placed over the surface) followed by reseeding upon completion of project. Seed with native seed mix as prescribed by botanist. Place slash, adjacent woody debris or duff over disturbed ground to resist rain splash. See the subsoiling prescription in the Soils Report.	N/A	4-86	RF-3c, C-12	Road-6
73	Implement suitable measures to re-establish stable slope contours, and surface and subsurface hydrologic pathways on temporary roads where necessary and to the extent practicable to avoid or minimize adverse effects to soil, water quality and riparian resources.	Yes	4-77 4-80	RF-3c, C-12	Road-6
74	Implement measures to promote infiltration of runoff and intercepted flow and/or desired vegetation growth on the road prism and other compacted areas. This may include seeding, installation of waterbars, pulling berms, mulching with native material, scarifying or subsoiling. Where possible and needed, skid trails will be subsoiled and/or have logging slash and large wood left.	Yes	4-77 4-80	RF-3c, C-12	Road-6
75	Close and/or physically block re-opened closed roads and temporary road entrances so that unauthorized motorized vehicles cannot access the road after project implementation.	Yes	4-77 4-80 4-86	RF-3c, C-12	Road-6
Snow Removal					
76	Use existing standard contract language (C5.316# or similar) for snow removal during winter logging operations to avoid, minimize or mitigate adverse effects to soil, water quality and riparian resources.	Yes	4-77 4-78		Road-8
77	During snow plowing side casting of materials will not occur where these materials could be	Yes	4-77 4-78		Road-8

Item	Design Feature	Timber Sale Contract	Forest Plan	PACFISH	BMP- National Core Technical Guide (2012)
	directly or indirectly introduced into a stream, or where the placement of these materials could contribute to the destabilization of the slope.				
Equipment Refueling and Servicing					
78	Refueling, repair, and maintenance of equipment will be done at landings or on forest roads outside of RHCAs.	Yes	4-77 4-78	RA-4, C-17	Road-10
79	Spill containment materials would be required on-site to ensure that spilled fuel will not leave the site.	Yes	4-77 4-78		Road-10
80	Spill prevention, containment, and countermeasures (SPCC) plans are required if the volume of fuel exceeds 660 gallons in a single container or if total storage at a site exceeds 1320 gallons.	Yes	4-77 4-78		Road-10
Water Drafting (e.g. Dust Abatement and Prescribed Fire)					
81	Draft from existing roads to the extent practicable.	Yes	4-77 4-78	RA-5, C-17	WatUses-3
82	Do not excavate stream bed to create pools to draft from.	Yes	4-77 4-78	RA-5, C-17	AqEco-2
83	When water drafting, sources will be monitored for reduced flows. When and if low flow (less than 5 CFS) conditions are identified, spring-fed ponds will be used as sources prior to the use of stream sources whenever feasible. When spring-fed ponds are not feasible, stream sources can be used but pumping rates must not reduce flows to less than 5 CFS. If the stream has less than 10 CFS, stream flow cannot be reduced more than 1/10th of the existing stream flow and will discontinue drafting if this amount is exceeded.	Yes	4-77	RA-5, C-17	Road-4 WatUses-3
Prescribed Fire Activity Objective: Avoid, minimize, or mitigate adverse effects to soil, water quality, and instream riparian resources that may result from wild land/prescribed fire activities.					
84	Alter prescribed fire prescriptions and control actions in the RHCAs as needed to maintain ecosystem structure, function and processes.	N/A	4-166	FM-4, C-16	Fire-2
85	Slash piles will be placed at least 75 ft from the stream or lopped and scattered within the RHCA buffer. Slash piles within 100 ft of streams will be no larger than 100 ft^2.	N/A	4-77 4-80 4-166	FM-4, C-16	Fire-2
86	Extreme care will be taken to avoid consuming more of the residues and forest floor (litter and duff) than necessary to meet burn objectives. Retain as much duff as possible, while meeting fuel reduction objectives to control erosion and provide organic matter.	N/A	E-27	FM-4, C-16	Fire-2
87	Fuels management in Class I and III RHCAs will be designed and implemented within the constraints of 10% exposed mineral soils and 80% stream surface shading.	N/A	4-166	FM-4, C-16	Fire-1, Fire-2
88	Extreme care will be practiced when burning on steep slopes and on volcanic soils which are highly erodible. With broadcast, jackpot and underburning, soil exposure will be limited to 20 % or less of the area on steep slopes.	N/A	E-27	FM-4, C-16	Fire-1, Fire-2

Item	Design Feature	Timber Sale Contract	Forest Plan	PACFISH	BMP- National Core Technical Guide (2012)
89	An unburned buffer of vegetation along streams will be maintained to protect riparian vegetation and reduce sedimentation. There will be no ignition within perennial RHCAs, however fire will be allowed to back into RHCAs. Prescribed fire may take place near perennial water in some locations. This low intensity fire will rarely kill shade-producing vegetation.	N/A	E-27	FM-4, C-16	Fire-2, Veg-3
90	Care will be taken to limit the severity of the burn in and along intermittent streams. To decrease fire intensity and fire effects, ignitions will need to occur within Class IV stream channels. This allows prescribed fire specialist to control the rate of spread and flame length. If fire was to establish down slope with unburned fuels above a head fire could establish, especially on steeper slope. Lighting during prescribed burning will take place in Class IV RHCAs. This will be done to improve the effectiveness of existing roads and trails as fire breaks. Lighting in RHCAs eliminates the need for constructed fire lines.	N/A	E-27	FM-4, C-16	Fire-2, Veg-3
91	Fireline construction will only occur where necessary. Any fireline constructed will be to minimal standard. Locations will be evaluated post-harvest. All firelines will be waterbarred and seeded at project completion, as needed.	N/A	4-166	FM-1, C-15	Fire-2
92	Fireline construction - blackline: Backlines are the preferred method of fireline construction. Often they are associated with natural barriers or roads to widen the defensible area. Black lining can provide a wide fireline without the disturbance that occurs with other methods.	N/A	4-166	FM-1, C-15	Fire-2
93	Fireline construction- handline: Hand firelines will be used only when burn conditions indicate the need to control the creep of fire in the duff. There is the potential that fall burning will require the use of more handlines than spring burning because of lower fuel moisture and the higher risk of fire creeping into unwanted areas. Burning will occur during times (season and time of day) of relatively higher humidity to reduce the need of handline in RHCAs. Chainsaws will be used to cut overhanging brush and large logs. Line construction will remove the duff the layer to mineral soil no more than 18 inches wide. Any line constructed will be rehabbed (such as pulling berms and scattering slash) and water barred.	N/A	4-166	FM-1, C-15	Fire-2

Design Features for Large Woody Material Placement

Item	Design Feature	Forest Plan	PACFISH	BMP- National Core Technical Guide (2012)

Aquatic Ecosystem Management Objectives: reestablish and retain ecological resilience of aquatic ecosystems to achieve sustainability; avoid, minimize or mitigate adverse impacts to water quality when working in aquatic ecosystems; design and implement stream channel projects in a manner that increases the potential for success of project objectives.				
94	Use a reference condition to determine the natural potential water quality and habitat conditions.	4-59, 4-164	FW-1, C-18	AqEco-1
95	Determine stream type and classification using suitable accepted protocols	4-59, 4-164	FW-1, C-18	AqEco-4
96	Determine design velocities appropriate to the site	4-59, 4-164	FW-1, C-18	AqEco-4
97	Design channels with natural stream pattern and geometry and with stable beds and banks; provide habitat complexity where reconstruction of stream channels is necessary	4-59, 4-164	FW-1, C-18	AqEco-4
98	Consider sediment load (bedload and suspended load) and bed material size to determine desired sediment transport rate when designing channels	4-59, 4-164	FW-1, C-18	AqEco-4
99	Add or remove rocks, wood, or other material in streams only if such action maintains or improves stream condition	4-59, 4-164	FW-1, C-18	AqEco-4
100	Choose vegetation appropriate to the site to provide streambank stabilization and protection adequate to achieve project objectives	4-59, 4-164	FW-1, C-18	AqEco-4
101	Use natural stabilization processes consistent with stream type and capability where practicable rather than structures when restoring damaged streambank	4-59, 4-164	FW-1, C-18 FW-1, C-18	AqEco-4
102	Use suitable measures to protect the waterbody when preparing the site for construction or maintenance activities	4-59, 4-164	FW-1, C-18	AqEco-2
103	Schedule construction or maintenance operations in waterbodies to occur in the least critical periods to avoid or minimize the effects to sensitive aquatic and aquatic-dependent species that live in or near the waterbody	4-59, 4-164	FW-1, C-18	AqEco-2
104	Use suitable measures to avoid or minimize impacts to the waterbody when implementing construction and maintenance activities	4-77, 4-78	FW-1, C-18	AqEco-2
105	Use suitable measures to divert or partition channelized flow around the site or to dewater the site as needed to the extent practicable	4-77, 4-78	FW-1, C-18	AqEco-2
106	Pursuant to project implementation, all necessary permits (e.g. CWA Sec. 404/401) and clearances would be obtained.	4-77, 4-78	FW-1, C-18	AqEco-2

Table 1. Criteria for equipment trails in or around Class I, III and IV RHCAs

<table>
<tr><th></th><th colspan="2">Sediment Buffer Width</th><th colspan="2">Activity Area</th><th>Max Trail distance or activity allowed</th></tr>
<tr><td rowspan="3">A</td><td rowspan="3">First 100ft from stream edge has a slope between 0%-20%</td><td rowspan="2">Yes</td><td rowspan="2">Activity Area Slope < 35% or >35%?</td><td><35%</td><td>600ft*</td></tr>
<tr><td>>35%</td><td>Only Non-Ground Based Harvest and Prescribed Fire</td></tr>
<tr><td>No</td><td>Go to B or C</td><td colspan="2"></td></tr>
<tr><td rowspan="2">B</td><td rowspan="2">First 75ft from stream edge has a slope between 21%-35%</td><td>Yes</td><td rowspan="2">Activity Area Slope < 35% or >35%?</td><td><35%</td><td>225ft*</td></tr>
<tr><td>No</td><td>>35%</td><td>Only Non-Ground Based Harvest and Prescribed Fire</td></tr>
<tr><td>C</td><td>35% or more</td><td colspan="3">Yes</td><td>Only Non-Ground Based Harvest and Prescribed Fire</td></tr>
</table>

*Maximum distance of trail unless the slope is broken by topography or water bars

Table 2. Treatments in Class I RHCAs

Height of trees to be cut	Treatment Zone Width (ft)[1] Hillslope < 35%	35 – 60%	> 60%	Silvicultural[2] Treatment	Fuels[3] Treatment
no trees cut	0 -15	0 - 15	0 - 15	No treatment	BF
< 20 ft	15 - 35	15 - 35	15 - 55	Hand thin	BF, LS
< 60 ft	35 - 75	35 - 75	55 - 75	Hand thin	BF, LS
< 60 ft	75 – 300	75 – 300	85 - 300	Hand thin	BF, FL, HP, LS, L

[1]width extends from the edge of the stream bank (Refer to Table 1 for skidding distance specs); [2]thinning treatments would be consistent with Forest Plan Standards for shade (pg 4-60) and Upper Grande Ronde TMDLs for temperature, sedimentation, and dissolved oxygen and the Umatilla River Basin biological criteria TMDL; [3]Fuels: BF-Backing Fire; HP-Hand Pile; LS-Lop and Scatter; MP-Machine Pile; Lighting-L; Fire Line-FL [4]Ground-based: Skidder, Feller-Buncher, Harvestor-Forwarder

Table 3. Treatments in Class III RHCAs

Height of trees to be cut	Treatment Zone Width (ft)	Silvicultural Treatment	Fuels Treatment
Hillslope < 35%			
no trees cut	0 -15	No treatment	BF
< 20 ft	15 - 35	Hand thin	BF, LS
< 60 ft	35 - 75	Hand thin, cable yard	BF, LS
< 21” diameter	75 – 150	Hand thin, ground based[4]	BF, FL, HP, LS, L, MP
Hillslope 35 – 60%			
no trees cut	0 - 15	No treatment	BF
< 20 ft	15 - 35	Hand thin	BF, LS
< 60 ft	35 - 75	Hand thin, skyline	BF, LS
< 21” diameter	75 - 150	Hand thin, skyline	BF, FL, HP, LS, L
Hillslope > 60%			
no trees cut	0 - 15	No treatment	BF
< 20 ft	15 - 55	Hand thin	BF, LS
< 60 ft	55 - 85	Hand thin, skyline	BF, LS
< 21” diameter	85 - 150	Hand thin, skyline	BF, FL, HP, LS, L

Table 4. Treatments in Class IV RHCAs – Commercial and Non Commercial Units

RHCA Zone	Width (ft)[1]	Silvicultural Treatment[2]	Fuels[3]
Inner Gorge	Site-specific	Hand thin	BF
Slope < 35%			
Inner Zone	0-75	Hand thin, cable yard	L, BF, LS
Outer Zone	75-100	Hand thin, ground-based[4]	All
Slope > 35%			
Inner Zone	0-75	Hand thin, skyline	L, BF, LS
Outer Zone	75-100	Hand thin, skyline	BF, LS, HP, L, FL

[1]width extends from the edge of the stream bank (Refer to Table 1 for skidding distance specs); [2]thinning treatments would be consistent with the Upper Grande Ronde sedimentation TMDL and the Umatilla River Basin biological criteria TMDL; [3]Fuels: BF-Backing Fire; HP-Hand Pile; LS-Lop and Scatter;MP-Machine Pile; Lighting-L; Fire Line-FL [4]Ground-based: Skidder, Feller-Buncher, Harvestor-Forwarder

ATTACHMENT 6

Alternative B - Treatments within Class I and Class III RHCAs

Unit	Silviculture Rx	Stream	Orient-ation	Order	CT (ac)	NCT (ac)		Canopy Cover	Stream Length in RHCA (ft)		Temp Roads (ft) in RHCA	Comment
					RHCA Class				Stream Class			
					III	I	III		I	III		
15B	Riparian Rx	Spring Ck Trib 4	SE-NW	3	11			60		3000	100	FR3145020 Level 1; RHCA treatment only on east side of stream
16B	Riparian Rx	Spring Ck Trib 4	SE-NW	3	5			70		1450	1100	FR3145 Level 1; reinstall 36" cmp; RHCA treatment only on east side of stream
41B	Riparian Rx	Thomas Ck Trib	SE-NW	2	7			50		1350		Temporary road, former FR3100239
61	Intermediate-NCT	Thomas Ck Trib	SE-NW	3			18	55		2700		Same tributary as Unit 41B
123	NCT	Thomas Ck	N-S	2			1	30		50		
125	NCT	Thomas Ck Trib	E-W	2			1	60				RHCA is in the secondary shade zone only
21	NCT	Dry Ck	N-S	4		14	1	75	1200	250		
24	Intermediate-NCT	Dry Ck Trib	NW-SE	2			2	40		400		
26	NCT Variable Density-regen	Dry Ck Dry Creek Trib	NE-SW NW-SE	4 1	1	2		50 30		75		Class I - secondary shade zone west of FR32; primary shade zone between FR32 and Dry Ck no thinning
28	Intermediate-NCT	Dry Ck	N-S	4		0.4		70				RHCA is in the secondary shade zone only
35	Intermediate-NCT	Dry Ck	N-S	4		1		85				RHCA is in the secondary shade zone only
111	NCT	Dry Creek Dry Creek Trib	NE-SW NW-SE	4 1		1	2	30		600		adjacent to unit 26
112	NCT	Dry Creek	N-S	4		2		25			25	Level 1 FR3200140; secondary shade zone
117	NCT	Dry Ck Trib	NW-SE	2			1	10		15		
20	Variable Density-regen	Phillips Ck Trib	NW-SE	2	1			50		350		
60	Intermediate-Commercial	Phillips Ck Trib	N-S	2	2			50		250		
70	NCT	Phillips Ck Trib	SW-NE	2			9	50		1200		
73	NCT	Phillips Ck Trib	S-N	1			12	20		2000		

75	NCT	Phillips Ck Trib	SW-NE	1			1	25				RHCA is in the secondary shade zone only of trib in Unit 73
80	NCT	Phillips Ck Trib	W-E	2		0.3	4	45		650		
82	NCT	Phillips Ck	NW-SE	5		16		15	1150			old clearcut unit
94	NCT	Phillips Ck	NE-SW	2			8	10		700		old clearcut unit
96	NCT	Phillips Ck Trib Phillips Ck Trib	NE-SW SE-NW	2 2			4 9	15		750 1300		old clearcut unit
97	NCT	Phillips Ck	NE-SW	3		14		30	950			old clearcut unit
99	NCT	Phillips Ck Phillips Ck Trib	N-S NW-SE	4 3		11	 2	70 25	600	 350		FR3738 close to east; clearcut, but tree corridor west of Phillips Ck
100	NCT	Phillips Ck Trib	NE-SW	2			6	15		800		old clearcut unit
101	NCT	Phillips Ck Phillips Ck Trib	N-S E-W	4 2		13	 3	20 10		900 600		old clearcut unit
102	NCT	Phillips Ck Phillips Ck Trib	NW-SE E-W	4 2		12	 8	20	900	 1400		old clearcut unit
104	NCT	Phillips Ck	NW-SE	4		17		10	1200			old clearcut unit
106	NCT	Phillips Ck Phillips Ck Trib Phillips Ck Trib	NW-SE W-E NE-SW	4 2 2		15	 5 1	5 15 5	1150	 800 500		old clearcut unit
107	NCT	Phillips Ck Phillips Ck Trib	NW-SE	4 2		16	 3	5 15		1200 400		old clearcut unit
129B	NCT	Phillips Ck	NE-SW	4		3		60				thin strip of PIPO plantation east of FR3738 in secondary shade zone
129B	NCT	E. Phillips Ck	NE-SW	4		34		40	2600			

Orientation – predominant direction of streamflow; Order – stream order; CT = Commercial Thin; NCT = Non-Commercial Thin;
Canopy Cover – estimated from aerial photos
Alternative C: Would not include Units 15B, 16B and 41B.
Alternative D: Would not include Units 15B, 16B, 20, 24, and 41B.
Unit 26 Dry Creek Tributary Class III changes from CT to NCT.
Unit 60 changes from CT to NCT.

ATTACHMENT 7 – WEPP ROAD MODEL RESULTS

Alt B	No Haul	Thomas Creek WEPP Road						
		AGG		INS		NAT		
		Open	Closed	Open	Closed	Open	Closed	
stream crossings:		47	6	17	9	7	11	97
lb	no traffic		16		16		40	
lb	low	29		29		140		
lb		1363	96	493	144	980	440	3516
							tons	1.8

Alt B	Haul	Thomas Creek WEPP Road			
		AGG	INS	NAT	
		Open	Open	Open	
stream crossings:		53	26	18	97
lb	no traffic				
lb	high	77	77	401	
lb		4081	2002	7218	13301
				tons	6.7

Alt C	No Haul	Thomas Creek WEPP Road						
		AGG		INS		NAT		
		Open	Closed	Open	Closed	Open	Closed	
stream crossings:		47	6	17	8	7	11	96
lb	no traffic		16		16		40	
lb	low	29		29		140		
lb		1363	96	493	128	980	440	3500
							tons	1.8

Alt C	Haul	Thomas Creek WEPP Road			
		AGG	INS	NAT	
		Open	Open	Open	
stream crossings:		53	25	18	96
lb	no traffic				
lb	high	77	77	401	
lb		4081	1925	7218	13224
				tons	6.6

Alt D	No Haul	Thomas Creek WEPP Road						
		AGG		INS		NAT		
		Open	Closed	Open	Closed	Open	Closed	
stream crossings:		47	6	17	7	2	8	87
lb	no traffic		16		16		40	
lb	low	29		29		140		
lb		1363	96	493	112	280	320	2664
							tons	1.3

Alt D	Haul	Thomas Creek WEPP Road			
		AGG	INS	NAT	
		Open	Open	Open	
stream crossings:		53	24	10	87
lb	no traffic				
lb	high	77	77	401	
lb		4081	1848	4010	9939
				tons	5.0

		Thomas Creek WEPP Road						
Alt E	**No Haul**	AGG		INS		NAT		
		Open	Closed	Open	Closed	Open	Closed	
stream crossings:		47	6	17	9	7	15	101
lb	no traffic		16		16		40	
lb	low	29		29		140		
lb		1363	96	493	144	980	600	3676
							tons	**1.8**

		Thomas Creek WEPP Road			
Alt E	**Haul**	AGG	INS	NAT	
		Open	Open	Open	
stream crossings:		53	26	22	101
lb	no traffic				
lb	high	77	77	401	
lb		4081	2002	8822	14905
				tons	**7.5**

Summary

tons	**Alt B**	**Alt C**	**Alt D**	**Alt E**
haul	6.7	6.6	5.0	7.5
pre haul	1.8	1.8	1.3	1.8
difference	**4.9**	**4.9**	**3.6**	**5.6**

Assumptions:

closed roads have insloped and vegetated ditch
open roads have insloped and bare ditch
closed roads receive no traffic
open roads receive low traffic under normal use
open roads receive high traffic under log haul

Input:

climate: customized to project area	
soil texture and percent rock fragments	silt loam, 20% rock fragments
road design: inslope with bare or vegetated ditch	see assumptions
road surface: gravel or native material	from GIS
traffic: none, low, high	see assumptions
road segment gradient, length, width	4%, 200 ft, 14 ft
road fill gradient, length	50%, 15 ft
road fill buffer gradient, length	25%, 50 ft

Output:

pounds of sediment leaving the buffer

http://forest.moscowfsl.wsu.edu/fswepp/
http://forest.moscowfsl.wsu.edu/fswepp/docs/wepproaddoc.html